POWER PLANT ENGINEERING

Trade-mark reg. U. S. Pat. Office

VOL. XXIII. CHICAGO, MAY 1, 1919 No. 9

Independent Illinois Power System

COMPANY LOCALLY FINANCED AND OPERATED SERVES PROSPEROUS RURAL COMMUNITIES WITH LOW-RATE CURRENT

ASIDE FROM the historic fact that Abe Lincoln once tramped its streets, Petersburg, Ill., also possesses the largest independent power station in that state. Located in the east central part of the state, The Abbott Light & Power Co. has 45 miles of line, supplying a lighting and power load of 400 kw. to Petersburg and 9 neighboring towns, covering 5 counties.

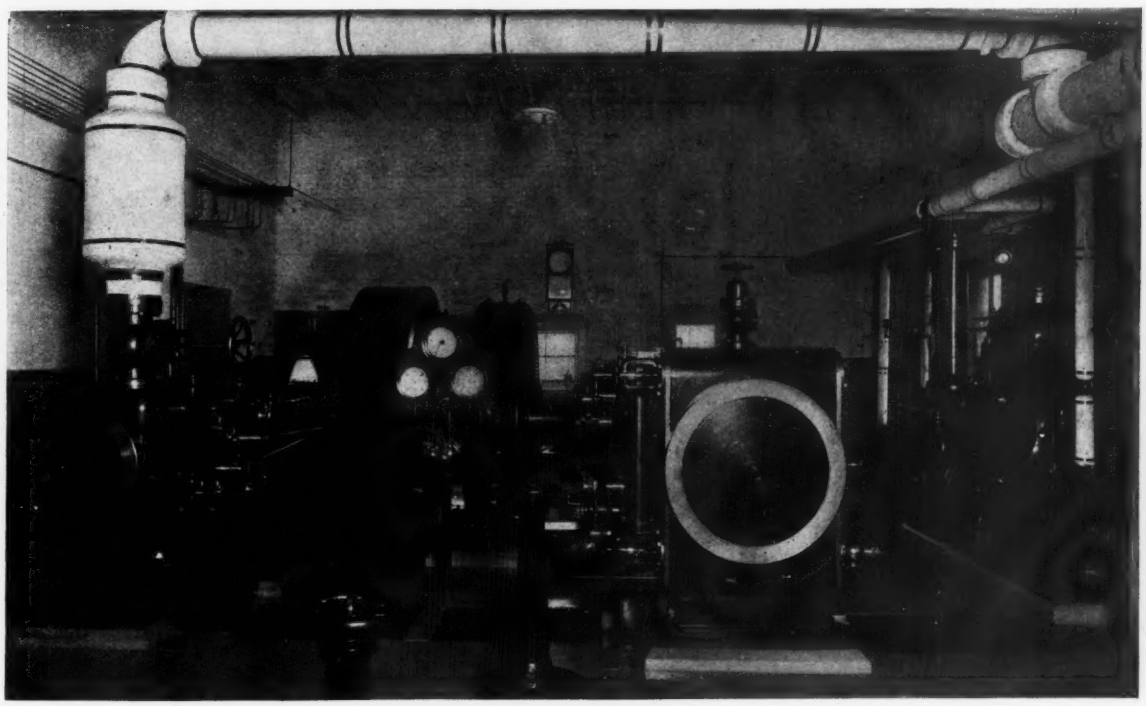

FIG. 1. 450-HP. MAIN GENERATING UNIT

Sixty-cycle alternating current is generated at 2300 volts, 3-phase, and stepped up to 16,500 volts outside the town limits, with an indoor substation. Outdoor and indoor substations are subsequently employed for changing voltages at the limits of the various towns. Transformer equipment for substations is installed in 50 and 75-kw. units. All outdoor transformer sets are mounted on creosoted wooden platforms. Spaced approximately 40 to the mile, 30-ft. poles, with No. 16 bare copper wire are employed on the transmission line. Most of the lines were laid out along the railroads because of the easy distribution of material and the elimination of expensive sites. Figure 2 shows the territory covered by the main transmission system.

Districts served by the company are quite prosperous and up to date; their customers want and appreciate the modern electrical conveniences. Residential needs, street lighting, coal mining and other industrial equipment and the cream separator and dough-mixing motors of the farmer from the load.

Not shown on the transmission line map are a number of farmers' lines, extending out to small communities. These lines vary from one to five miles in

length, and serve anywhere from six to fifteen customers. In these instances the power company has supplied the poles and equipment, and such construction labor as needed, at cost. Frequently the farmers or their hired help would set the poles and string wires during their dull season, making the erection cost extremely low. Although the neighborhood owns the extension line, the

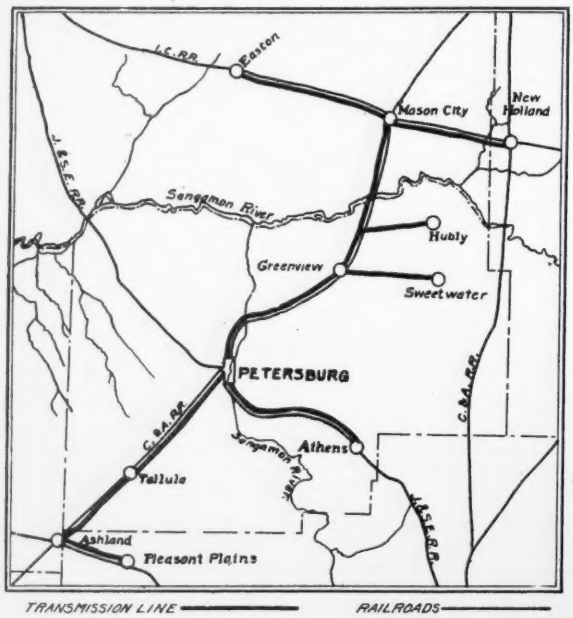

FIG. 2. TERRITORY COVERED BY TRANSMISSION SYSTEM

power company assumes the care and maintenance without charge. This type of load is steadily increasing and is extremely desirable, for load factor improvement, profitable operation and the establishment of public good-will.

Prior to the organization of this company, seven of the nine towns on the system were served by local plants that shut down at 10:30 p.m. and offered no day service.

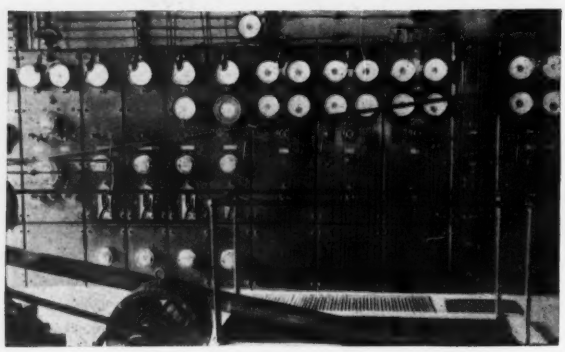

FIG. 3. DISTRIBUTING BOARD OF PETERSBURG STATION

After tying the towns together, the communities were better pleased with the continuous service. Furthermore, current rates were 33 1/3 per cent lower than they were under the old system of service.

Distribution of the current is regulated by the modern 11-panel switchboard shown in Fig. 3. Outside meters are installed for all customers to facilitate the taking of regularly periodic readings.

Neatness of the Station

Tribute is due John B. Trigg, chief engineer of the plant since its installation 20 years ago, for the exceptionally inviting appearance of the station and its equipment. Shining floor and wainscoting of the engine room are painted light gray, walls and ceiling are white and the machines are dark green. All is spick and span, with the crisp orderliness of a new installation. And the smooth, efficient operation of the machinery pleasingly matches the general atmosphere.

Recently placed in operation as the main unit is a 450-hp. cross-compound condensing non-releasing Corliss engine, directly connected to a 312-kv.a. alternator with a belted exciter. It is of the self-contained automatic type, with centrifugal interior governor. Figure 1 shows this unit with a jet condenser located near the low-pressure side.

Other machines are a 200-kv.a. unit, operated by an 18 by 36-in. Corliss, and a 100-kv.a. alternator by a 100-hp. high-speed engine. This last named unit ordinarily carries the Sunday load. Frequently the belt is removed and the generator operates as a synchronous condenser on the line.

FIG. 4. GENERAL ENGINE ROOM VIEW

Exhaust steam from these engines, after passing through the feed water heater, is employed for heating several buildings in the block. Occasionally the 18 by 36-in. Corliss is operated condensing; the exhaust valve in that case is given an extra lap of 1/32 in. When only the large condensing engine is running, a small amount of steam is bled from the receiver to satisfy the heating load, after first passing through the feed-water heater.

Condensing and Spray Pond

From the large condensing engine, a 12-in. exhaust leads to a jet-type condenser through an oil separator, vacuum being furnished by a 10 by 16 by 20-in. simplex pump.

Water for the condenser cooling pond consists of rain water drained from neighboring buildings and water from the Sangamon River, one-third of a mile distant. The spray pond, 63 ft. square and with a depth of 5 ft., has 6 spray units, each having five 3/8-in. nozzles. A 6-in. line runs from the condenser to the spray pond, subsequently reducing to 4 in. beyond the first spray arm. The bottom of the pond slopes 6 in.

toward the suction end. To the first spray unit, 6-in. pipe is employed, then 4½-in. and 3½-in., successively. Figure 5 shows the pond arrangement.

With non-condensing operation, feed water is drawn direct from the spray pond. When the condenser is operating, a 3-in. tap in the discharge line before the pond is reached, is used for feed water, which is delivered to the 300-hp. open feed-water heater by a 6 by 4 by 6-in. duplex pump, equipped with an automatic pressure regulator.

From the heater the water is delivered to the boilers through one of two 6 by 4 by 6-in. duplex pumps or a 6 by 5-in. simplex pump, discharging to a 2-in. feed line.

Forced feed lubricators are employed throughout the station.

Low Fuel Costs

Steam at 125-lb. pressure is supplied by one 200-hp. and two 100-hp. water-tube boilers, but a large boiler is soon to be installed. Slack coal is hauled to the plant by wagons from a mine just a mile away and is costing from $1.50 to $2.50 a ton.

Regardless of the comparatively low fuel cost, no

FIG. 5. SPRAY POND AT PETERSBURG

waste is permitted. Draft gages, automatic damper regulators and stack temperature recorders are employed to aid economical operation. Mr. Trigg has found that it costs twice as much to fire up a boiler filled with cold water after cleaning, as one filled with warm water. The absence of a cold water line near the boilers is assurance that warm water will be used at all times.

Four men, in addition to the chief, operate the plant, and their plan has proven extremely satisfactory to all concerned.

Coming on from midnight until 9 a.m., the first man is responsible for the cleaning of one engine and also fires the boiler two or three times each hour. The second man is on from 6 a.m. until 3 p.m.—cleaning up an engine from 6 until 9, firing from 9 until 1, then back in the engine room until 3. Coming on from 1 p.m. until 10 p.m., the third man does nothing but fire and attend to the boilers. The fourth man serves from 3 p.m. until midnight. Each man is held responsible for specific duties and takes his turn at boiler cleaning, a light occupation at this plant. As far as possible, each man is encouraged to depend upon himself and think out his problems.

Norway's Water-Power Plans*

During late years the demand for electric power in Norway has increased so enormously, not only in the cities, but also in the country districts, that the water power now developed has not been nearly sufficient. The shortage has been especially in the cities and country districts of the eastern and southern part of the country and in the smaller counties. The delivery of 150,000 hp. to the eastern part of Norway from the Tysso Falls, in Hardanger district, will, however, give them considerable electric power for distribution.

There seems to be good prospect of finishing the trunk line via Seljestad and Kongsberg to Christiania and other districts this year, commencing by supplying 30,000 hp. and increasing this to 150,000 hp. the promise of high government officials having been obtained to supply a quantity of cable, of which there is a great shortage in Norway. When all the works at Tysso Falls, say in 3 or 4 years, will be ready, it will be possible from these to supply the trunk line with 275,000 hp. When all expenses have been paid for running the works, interest, amortization, and taxes, the cost of production will be only about 1 cent per kilowatt-hour delivered in Christiania.

It is expected that the trunk line can be supplied with 4,000,000 to 5,000,000 electric horsepower within a not too distant future. In inner Hardanger and Telemarken districts alone are 1,500,000 available horsepower near the trunk line, which may be directed toward the east and south.

The manager of the Christiania Electrical Works, Norberg Schulz, has for a long time been working on a great plan with regard to power lines for the city. The first step was taken in January, 1916, when the municipality bought Holsvarsvattnet, estimated to deliver, roughly, 100,000 horsepower. The next step was the purchase in December, 1917, of a series of waterfalls in the Hallingsdals River, giving 40,000 hp. The purchase of Aurlands Falls in the western country for $1,340,000, which was closed some months ago, was the last step in this plan. These falls are estimated to supply 300,000 to 400,000 hp. The trunk line from the Aurland Falls to Christiania will be about 180 mi. long.

Akershus County Council last year decided to exploit as soon as possible the Raanaas Falls in the Glommen district, and the work is progressing. The falls will produce about 64,000 hp. The expenses are estimated at $5,000,000. The work is expected to be finished in about 4 yr., and only Norwegian laborers are to be employed on it.

—Commerce Reports.

The most potent argument for the Victory Loan is not one of money and interest: It is one of self-preservation. There is unrest and discontent all over Europe. Industrial conditions are so bad there that the governments have an uphill job making ends meet. If the United States thinks it worth while to avoid the tempest of disorder that is convulsing Europe, the one indicated course is to put the Victory Liberty Loan through quickly.

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* From Svensk Handelstidning, Stockholm, transmitted by Commercial Attache Edwin W. Thompson, Copenhagen, Denmark.

Fuel Conservation Letters

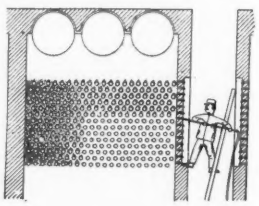
By Joseph Harrington, Formerly Administrative Engineer for the State of Illinois

As an introduction to the series of semi-monthly letters that we have arranged for with Joseph Harrington, it should be said that these are intended to be a continuation of the letters which Mr. Harrington published as Official Communications from the United States Fuel Administration when he was Administrative Engineer for the State of Illinois. The last of the official letters appeared in the December 15, 1918, issue and was the seventh of the series. For convenience of our readers we shall continue to number them as part of the original series, this letter being number eight. They are not intended in any way to be detailed descriptions of equipment, nor to enter into any refinements or technicalities of the subjects treated. These letters were intended, and the future ones will be of the same character, as regular periodic reminders to power plant owners and engineers on subjects pertaining to the conservation of coal. They are intended to be short, snappy, and to the point; and if they serve to make men think, they shall have fully accomplished their purpose.

It is hoped that all readers of Power Plant Engineering will take heed and immediately start a self-analysis that will lead up to the desirable ends emphasized by the writer. Editor.

Soot Blowing. Letter No. 8

EVERY boiler operator blows the soot from some of his boiler heating surfaces, but no operator blows all the soot from all of his heating surfaces. If he did, the continuous waste of heat up the chimney would be far less than it is now and the boss would be called upon to pay for much less coal than he is now.



Soot is one of the most efficient insulating materials known, and it has a remarkable talent for attaching itself to boiler tubes. It is the one ever-present and ever-increasing enemy of efficiency.

Soot begins to form the moment after the previous layer has been removed, and in six hours the deposit of soot in any boiler is sufficient to affect visibly the flue gas temperature. Remember that every 25 deg. in flue gas temperature represents 1 per cent of the coal fired. In eight hours, even with fairly clean combustion, the deposit of soot on the tubes will cause a rise of 50 deg.; and in twenty-four hours, will cause a rise of 100 deg.

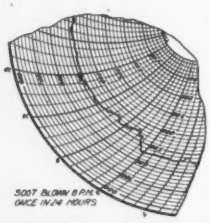
Soot should be blown every six hours. As a matter of record, the minimum observed saving by the use of effective soot blowing is 3 per cent. Assuming a horizontal water-tube boiler of 500 hp, the saving of 3 per cent figures about as follows:

2000 lb. coal per hour	$ 6.00
3 per cent saving	.18
Per day of 10 hr.	1.80
Per month 30 days	54.00
Approximate cost of mechanical soot blower	600.00

or 100 per cent return in about 11 months.

In a water tube boiler, it is a physical impossibility properly to clean the heating surfaces by hand. Firemen object to wrestling with a hot steam lance in a narrow alley, and they will not do it oftener than they are absolutely compelled to. Mechanical soot blowers are much more easily operated, do the work more effectively, and pay for themselves in a short time. The removal of soot, accounting for 2 per cent of the coal, well warrants the necessary expenditure for blowers.

'If you don't make soot you won't get any on the heating surface. Watch your furnace, therefore, and do everything possible to secure smokeless combustion. Fire little and often; provide over-fire air; use suitable coal; increase the length of flame travel, or do whatever you find promotes clean combustion.



Try the effect of installing a recording flue gas temperature thermometer in your uptake, and see how interesting it is to watch the effect of blowing. Get your firemen interested in keeping the flue gas temperature down. Study your type of boiler and find out where the lodgment of soot is easy, and then give special attention to these points.

Boilers differ greatly in their tendency to retain soot among the tubes. Where cleaning is difficult, extra effort is required—**but get it clean.**

Remember also that soot not only acts as an insulator, but when wet by steam condensation or leakage produces an acid which will corrode the heating surface in contact therewith.

Soot is your constant enemy. No trouble is so great as to warrant your neglecting this matter. Eternal vigilance is the price of efficiency.

Determining Economy of Steam Generation

Methods of Procedure and Equipment Required. By G. H. Sheasley

GENERATION of steam has as its basis the vaporization of water by the process of transferring heat thereto, such heat having previously been liberated from some sort of fuel by means of combustion. Consequently it is evident that the final result is dependent upon three separate but thoroughly interwoven processes:

1. Combustion of fuel within the furnace and the consequent liberation of its heat.

2. The transfer of some portion of this heat to the water contained in the boiler.

3. The vaporization of the water, or its change from a liquid to a gaseous state, as a result of, and in proportion to, the heat transferred.

Therefore it follows that the third process being the result of the first two, its result is likewise a measure of their combined efficiencies, provided such result is known and reduced to terms of the heat contained in the quantity of fuel consumed in bringing it about. But, on the other hand, these results can by no means be taken as a measure of the separate efficiencies of either of the first two processes, and neither can the result of either of these be determined and taken as a reliable measure of the other or the third.

It must always be conceded that any condition detrimental to either combustion or radiation is bound to be detrimental to evaporation, but the reverse is not always true. The reason for this lies in the fact that it is entirely possible to have good combustion, as indicated by the pressure of a high percentage of CO_2 in the escaping flue gases, while at the same time the radiation of heat to the water, and the resulting evaporation will remain comparatively poor, due to the insulating effect produced by deposits of either soot or scale on the heating surfaces.

Soot or scale may be removed from heating surfaces and the evaporation materially improved; but in the case of scale removal, combustion would in no way be improved, while the removal of soot would improve it only in case natural draft was employed and the supply of air had previously been insufficient. Then the removing of soot would decrease the frictional resistance through the boiler, thereby increasing the vacuum in the furnace and increasing the supply of air drawn through the fuel bed; but if approximately the right amount of air was previously being supplied and combustion was fairly good, the removal of soot would tend to impair the combustion by causing the admission of excess air to the furnace unless the draft was decreased.

In some cases a low temperature of escaping flue gas is taken as an indication of good radiation and evaporation; but a low temperature of escaping gas is not conclusive proof that the evaporation is satisfactory, because poor combustion in the first place may be producing gases of a comparatively low temperature, while the infiltration of air through cracked or faulty settings or uptakes may have reduced the temperature of the gases to the desired limit even though the evaporation remained very poor. Consequently it may be seen that the results, as usually measured, of either combustion or heat radiation may prove decidedly misleading if taken as a measure of each other or of evaporation.

Even the evaporation when taking into consideration the quantity and quality of steam apparently generated cannot always be taken as a reliable measure of actual operating efficiency, unless it is definitely known that the coal and water weighing or metering devices are accurate and that there is no water leaking from the boilers. One or more leaky blowoff valves will have the effect of making an otherwise poor rate of evaporation seem ideal, while at the same time coal is being worse than wasted in the heating of water to the temperature within the boiler, which merely finds its way to the sewer or some other out-of-the-way spot.

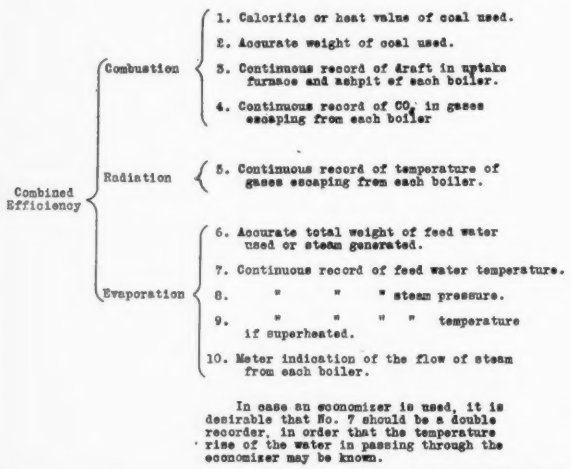
The writer has in mind one instance in particular of this kind that came under his observation. The chief engineer of a rather small industrial plant was asked if he figured his boiler efficiency daily. He rather proudly replied in the affirmative and to the effect that the daily average was around 75 per cent. When asked if he was certain that the records of coal consumed and water evaporated were correct, he replied that there could be no question but that they were, as the coal was carefully weighed and recorded by the coal passers, while the feed water meter had only recently been gone over and pronounced correct by a factory representative. Not wishing to argue the matter, it was dropped for the time being. In a short time the chief was called to the engine room, and during his absence an inspection of the main blowoff line showed it to be decidedly hot, while a closer inspection showed that, of the six boilers in use, the blowoff valves on four of them were leaking, as indicated by the branches from the valves to the main line being hot. Inspection of the blowoff discharge disclosed the fact that a stream of water about one-half the size of a man's wrist was constantly flowing from the pipe. The chief was then hunted up, and at first scoffed at the idea of four of his blowoff valves leaking. He was sure it was nothing more serious than a piece of scale lodged in one of the valves. Nevertheless, despite his best efforts at opening and closing the valves in order to drive out the supposed scale, the stream flowing from the end of the blowoff line did not decrease in size. A pail was then procured and the wastage weighed and the rate of flow timed. An approximate daily deduction in the amount of water evaporated was then calculated, with the result that the average of 75 per cent efficiency suddenly tumbled to 62 per cent, which no doubt was about right.

With many apologies for the leaky valves, and frequent requests that I refrain from informing any of the officials, the chief promised to see that the valves were removed the following Sunday, but I have often doubted if this was done, because he would have rather a difficult job of explaining the reasons for such a sudden and decided drop in efficiency to the management, who, by the way, were loud in their praise of the ability of their chief engineer as a man who not only could get results, but who could keep the plant in operation under all sorts of adverse circumstances. No doubt he had the ability

to keep the plant in operation, but his ability to take results for granted, coupled with the confidence of the officials, had undoubtedly cost this concern thousands of dollars in wasted coal.

Determining Performance

To determine the various conditions of operation and their relation to each other, of course, requires considerable detailed computation and study. Consequently when it is desired to determine these conditions with great accuracy, or to determine the final efficiency of steam generation that is being, or can be attained with any one or number of boilers in a given installation, it is necessary or at least desirable to resort to carefully conducted and somewhat exhaustive tests, with a sufficient number of observers for the gathering and recording of all data and notes of conditions of operation that would be expected to affect in one way or another the final result. A test being therefore invariably conducted for some specific reason, such as the determination of: (a) Efficiency under present conditions; (b) maximum efficiency; (c) maximum capacity; (d) relation of capacity and efficiency; (e) effect of different methods of


Combined Efficiency
Combustion
1. Calorific or heat value of coal used.
2. Accurate weight of coal used.
3. Continuous record of draft in uptake furnace and ashpit of each boiler.
4. Continuous record of CO_2 in gases escaping from each boiler
Radiation
5. Continuous record of temperature of gases escaping from each boiler.
Evaporation
6. Accurate total weight of feed water used or steam generated.
7. Continuous record of feed water temperature.
8. " " " steam pressure.
9. " " " " temperature if superheated.
10. Meter indication of the flow of steam from each boiler.
In case an economizer is used, it is desirable that No. 7 should be a double recorder, in order that the temperature rise of the water in passing through the economizer may be known.

RECORDS AND DATA UPON WHICH RESULTS MUST BE BASED

operation; (f) effect of rearrangement or change in design; (g) effect of different kinds of fuel.

The final conclusions reached, through an analysis and study of results and conditions, will have a direct bearing on the question or questions at issue; but regardless of how well it serves this purpose, or how elaborately reported upon, a test is of little practical value in the everyday operation of the plant unless adequate means are provided for the future conducting of what amounts to a continuous day-to-day test, with sufficient records of actual performance and conditions as to admit of a fairly accurate analysis of the results obtained. In this way only can information of value in eliminating objectionable conditions and the bringing about of desired improvements be obtained.

There was a time several years ago when the owner or manager had a plausible excuse for ignorance as to what was going on in his boiler plant. That excuse was the fact that no suitable instruments other than those of the indicating type being available, to have obtained useful daily performance records, other than the mere weight of coal consumed, would have required the continuous services of a corps of observers for noting and recording of operating data. This, of course, in nearly every case would have been out of the question, as the expense incurred would have either equaled or exceeded the saving that might have resulted.

The advent of recording and integrating instruments, together with automatic water and coal weighing apparatus, however, has reduced this necessity for manual labor and observation to minimum, consequently, with reliable recording and integrating instruments and appliances available for practically every boiler plant need, there is little excuse today for a lack of accurate operating records, and a knowledge of results that are and should be daily attained. Yet despite this fact in a large number of otherwise up-to-date manufacturing establishments where every known modern means that makes for speed and economy in production is employed, the boiler plant, if it could be said to be distinguished for any one particular reason, that reason would most likely be the lack of sufficient or suitable instruments for determining of daily operating data. In most plants will be found an installation consisting of at least some of the necessary equipment, but in comparatively few cases is this installation complete.

The coal situation during the past year, coupled with the efforts of the Fuel Administration, has done much toward bringing about a general realization of the importance of equipping plants with the necessary instruments and apparatus for the measuring of economy in the generation of steam which under force of circumstances was practically a matter of compulsion. Despite this fact, much yet remains to be done.

One plant will be equipped with means for determining fairly accurately the weight of coal burned, and possibly with recording CO_2 apparatus, while neither the feed water entering the boilers nor the steam generated is metered. No record of evaporation is possible, therefore high CO_2 is striven for and relied upon as a measure of efficiency, while, as previously stated, it is a measure of combustion efficiency only and not the efficiency of steam production.

Another plant will contain both coal and water weighing or metering devices, but with no continuous record of either one or both the steam pressure and feed water temperature. As a result of this condition it is impossible to determine the factor of evaporation. Again, the efficiency cannot be accurately determined, and the actual evaporation is relied upon as a measure thereof.

This method can also prove to be misleading, because a poor grade of coal may suddenly send the actual evaporation down; but at the same time it is entirely possible that the drop in evaporation may not have been as marked as the drop in calorific or heat value of the coal. In such case the efficiency would actually go up, while the opposite would be indicated by the evaporation, or vice versa. As an example, let us assume that we are using coal that has a heat value of 14,000 B.t.u. per pound. The actual evaporation with this coal is 9.50 lb. of water per pound of coal burned. Steam pressure averages 160 lb.; feed water temperature averages 200 deg. F. The factor of evaporation and temperature is approximately 1.06. Then the equivalent evaporation from and at 212 deg. F. is 9.50 times 1.06, or 10.07 lb.

and our efficiency becomes equal to 14,000 divided by the product of 10.07 and 970.4, or 69.8 per cent.

Another car of coal is received, the heat value of which is only 12,800 B.t.u. per pound, and the actual evaporation drops to 8.75 lb. of water per pound of coal. Our factor remains the same, so our equivalent evaporation is equal to 8.75 times 1.06, or 9.27 lb., and the efficiency equal to 12,800 divided by the product of 9 27 and 970.4, or 70.3 per cent, an actual gain of 0.5 per cent in overall efficiency despite a drop of 0.75 lb. in the actual evaporation. This should prove that this actual evaporation is little more reliable as a measure of efficiency than high CO_2 in the flue gas.

No definite or fixed rules can be laid down for the economical operation of a boiler plant, as the peculiarities of the installation, together with the service requirements, make of each a problem within itself, therefore, calling for special solution. The larger the plant the greater becomes the amount of detail and expense that is warranted in this direction; while the smaller the plant the more, of course, the reverse becomes true. However, the process in every case being directed toward the generation of steam, the necessary records and data, upon which results and conclusions must be based, naturally remain the same and should, in general, consist of the items indicated in the accompanying table.

Equipped with these records, and somebody with sufficient ability to make intelligent calculations and reach definite conclusions, the problem of economical operation can readily be solved, and the conservation of fuel and the resulting financial return become established facts.

Talking Through Space

DURING several years past, experiments have been reported with wireless telephones, but such trials have been for short distances, generally a few hundred feet, and under favorable conditions. The trials have been successful, but until the war started, little had been done in the way of practical application.

During 1915, however, a combination of wire and wireless telephony produced successful conversation between New York and Panama, San Francisco and Honolulu, wire transmission being used from New York to Arlington Heights, and sent from there by means of the Naval Radio Station towers. A little later, messages were exchanged between New York, via Arlington and the Eiffel Tower in Paris.

It was obvious that a great use of wireless telephony would be for talking between ships, from ships to land or airplanes and between airplanes and ground stations, but the problem, especially for airplanes, has great difficulties. For the long distance work there had been available heavy power plants and apparatus of unlimited capacity; but this would not be possible on ships, and certainly not on airplanes.

But it was possible to determine the space, weight and energy limitations for such work, and the Western Electric Co. then set to work to overcome the difficulties.

Major-General George O. Squier, chief signal officer, had secured, in 1916, the co-operation of the telephone and telegraph companies in assembling a reserve signal corps, ably assisted by Colonel J. J. Carty, chief engineer of the American Telephone and Telegraph Co. Frank B. Jewett, chief engineer of the Western Electric Co., was commissioned as major, later as lieutenant colonel, in the Signal Corps, and several of his assistants were also given commissions, so that the facilities of the various companies were available for engineering and experimental work.

When we entered the war, these men were called to active service, and given the work of developing signal apparatus and organizing a staff of experts for this work.

In May, 1917, after a conference with Major Jewett, Colonel Rees of the British Airplane Service and others, General Squier ordered that the apparatus for wireless telephony with airplanes be pushed as fast as possible, and Major Jewett, assisted by Captain Culver, of the Signal Corps, were assigned to have charge of the work. In July, 1917, the first tests were made at Langley Field and were so successful that plans were started for reducing the experimental apparatus to a practical manufacturing basis. Some problems were to get a power plant, readily portable and with sufficient energy capacity to transmit clearly through the roar of battle; also a receiving apparatus which would make speech audible above the racket and vibration of a 400-hp. unmuffled airplane engine. As a man in an airplane cannot hear himself talk, the difficulty of enabling him to hear a man some miles away, with no connection between, can be appreciated.

The thing has been done, however, and it is now possible for observer and pilot to talk to each other, to the headquarters on the ground, or to other airplanes in flight; so that an air squadron is as readily controlled as an infantry company, and can send back intelligence as definitely as an observer on the ground; the voice is not raised above ordinary loudness, and there is no more indistinctness than in ordinary wire-transmitted speech. The generator for the transmitting station on the airplane is wind driven, and so regulated that its power is nearly steady, whether the plane is climbing sharply or is in a nose-dive at 150 mi. per hr. The first trial of direction by direct command was in December, 1917, at Wright Field, and went without a hitch.

The problem, from that time on, was one of production, one item being vacuum tubes that were used in regulating the quantity of electricity for the telephone set. Up to January, 1918, the capacity for these was not over 200 a week, but by November, 1918, they were being produced at a rate of 1,500,000 a year for use in wireless telephone sets and with special telegraph equipment.

Besides the use on Navy and Army airplanes, all submarine chasers were supplied with the wireless telephone sets, so that a fleet could be controlled by a set in the commander's quarters as readily as if all commanding officers were sitting in a room together.

Such has been the development of one branch of one industry as a result of war's demands, and it is easy to see that the effect on the activities of peace will be far-reaching.—(From an interview with Dr. Frank B. Jewett in Telephone Review.)

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B. V. NORDBERG

CAME TO AMERICA AS A YOUNG MAN WITH SHIPBUILDING ASPIRATIONS, BUT BECAME A MASTER OF ENGINERY. BY WALTER PAINTER

BACK in 1908, the Anaconda Copper Milling Company, Butte, Montana, was confronted with a perplexing problem. They had on different properties—within a radius of one mile—some 30 shafts, each shaft requiring a separate steam plant for operating its hoist. Hoisting costs were great because of the high price of coal. An abundance of electric current was available but direct electric drives did not work out advantageously with their peculiarly fluctuating cycle of hoisting. This current was quite cheap when a uniform quantity was purchased and where there was an absence of peaks.

In Milwaukee was a shrewd engineer, named Nordberg, whose reputation for solving perplexing mining power problems was widespread. He responded to the call for aid and after a thorough study of the situation, proposed a compressed air system. Electric-driven air compressors were installed which were arranged to be started without the use of electricity, thus eliminating the starting peak. These compressors were connected up to a battery of air receivers in which a constant pressure was maintained by means of a static head, furnished by a lake, located above the receivers. Air was piped to the different shafts through a line forming a loop, and air-operated hoists, designed to use the air economically, installed at each shaft. At each hoist a reheater was installed to heat the air just before it was used. The entire system was a radical departure from "standpat" engineering practice, but it proved to be a notable engineering achievement.

BRUNO V. NORDBERG

Bruno V. Nordberg was born in Finland, April, 1857. His father, Carl V. Nordberg, operated a shipyard in Finland, having had experience with fast sailing ships in the United States, India and China. He was himself a sea captain and an ardent admirer of the American Merchant Marine, the clipper ships of which at that time were the finest in the world.

Throughout his boyhood Mr. Nordberg spent most of his open hours at the marine works of his father—out in the yards, on the sea, in the engine shops and in the designing room. At the age of 21 he was graduated from the Helsingfors University and shortly afterwards came to this country. It was his purpose to follow shipbuilding, strongest of his boyhood ambitions, and he settled in Milwaukee. His first job, however, was drafting with the E. P. Allis Co. and within a year he stepped ahead to become the right hand man of Edwin Reynolds, of Corliss engine fame. His work consisted of experimentation, designing, erecting and operation tests. Steam engines were then being rapidly improved—and Mr. Nordberg thrived in fertile pastures. His association with Mr. Reynolds proved a valuable asset in his later career.

In 1889, with a force of six men, Mr. Nordberg established his own concern, centering his efforts upon the production of a successful cutoff governor, which, with a variable load, effected a large economy over plain slide valve engines. In 1892 he built his first steam engine, to meet a special order for a Milwaukee brewery. It was a poppet valve design, size 24 by 48 in., and his company became a pioneer American builder of the present type of poppet valve engine. Subsequently he took up the manufacture of pumps, Corliss engines, hoists and compressors. He improved the Corliss engine, in various ways, made the engine frame in one piece and invented the full stroke valve gear.

In 1899 he designed a pumping engine with a new steam cycle which achieved noteworthy results and by which the efficiency of a steam engine was increased beyond the limits that heretofore were considered unattainable. In 1900, he was the first manufacturer to install individual shop motor drives on a large scale.

He early gained the confidence of the mining men in the copper mines of the upper Michigan peninsula, due to his ability to solve successfully problems related to mining machinery, and for a number of years his time was largely devoted to designing efficient hoisting, pump-

ing, compressing and stamping machinery for this district.

To meet the requirements of this locality Mr. Nordberg designed an extremely large cylindro-conical drum hoist, which became a standard design. He is now designing and building a hoist to operate at a maximum depth of 10,000 ft. for this district. This new machine will be the world's largest, as were some of the previous hoists at the time of installation.

During the war Mr. Nordberg directed his efforts toward quantity production of 1400-hp. vertical triple expansion engines to equip the new ships of the Emergency Fleet Corporation, and in designing special compressors for inflammable gases and machinery for liquefying gases.

For the past 26 years Mr. Nordberg has been an active member of the American Society of Mechanical Engineers, contributing many papers and discussions to its transactions as well as other technical journals.

Outside of engineering circles, he is extremely retiring and quiet—just as you would expect a busy man of 62 to be—but active and alert at his work. He recognizes no dead line or calendar limits to personal efficiency. In his home is a special laboratory where much of his experimental work is carried on, where new problems outside the field of engine design are studied. And at his office he is invariably knee-deep in work. It is his joy of living. He has two sons—one, B. V. E. Nordberg, is also an engineer and has charge of the oil engine department of the Nordberg Manufacturing Co.

Sailing does lure him away for a two or three weeks' annual cruise about Lake Michigan: he has owned a trim 62-ft. schooner, "Merlin," for 16 years. And sailing, he says, is a splendid sport for the engineer, an avocation affording possibilities seldom accorded it. To Mr. Nordberg it recalls the sport of his youth, sailing about the shores of the Baltic Sea and the Gulf of Bothnia.

Today he is president and chief engineer of the concern bearing his name. He has ascended in the manufacturing industry because he has successfully designed and produced reliable machinery. He had courage to enter new fields, to discard rule-of-thumb engineering methods and think through a practical solution to new problems. Ingenuity is the cardinal virtue of an engineer. And blended with his peculiar engineering skill and power to serve is a strongly marked executive ability which aided in the consummation of his large ideals.

Engineering vs. Business

By J. T. Beard, Jr.

SOME TIME ago the writer was in charge of some construction work the corps of surveyors of which was a pick-up gang with experience, more or less limited, in running levels. One day the rod man was taken ill and there was nobody to take his place other than a "rookie" whom we were breaking in. The man was fairly intelligent and for a while everything went smoothly.

At length he was told to set up at a point about 500 ft. distant, the elevation of which we were anxious to determine. While he had been within range of our voices we merely shouted instructions and he obeyed. When he got so far away that we had to signal to him, however, he was lost. He did not know the language. Between us there was a chasm which could not be bridged until he had learned the meaning of our signs.

Perhaps the reader wonders what this little story has to do with engineering or business. It is this: Between the modern engineer and business man there is a chasm similar to the one that lay between us and our "rookie." It is to the interests of both that they pull together. They are working toward the same end. Their methods of reasoning and analysis are much the same. And yet—there is this chasm.

They fail to reason in the same language. The business man knows his unit cost of production, but the engineer forgets that he understands little about horsepower and less about British thermal units. The engineer makes his recommendations in his own language and the business man vetoes them in his native tongue.

For this reason there is a conflict, or perhaps we should say misunderstanding, between these two factors—a misunderstanding which tends to promote delay instead of progress, ill feeling instead of team work and distrust instead of respect. And all because neither will take the pains to study the viewpoint and learn the language of the other. Let us look at the problem a little more concretely.

In the industrial world the power plant is frequently a neglected department of the organization. Usually it is left to its own resources, to work out its own salvation. The "men upstairs" are often oblivious to its existence as long as there is enough steam to turn the wheels of the mill.

When an emergency occurs, however, and the steam fails, the mill is down and the men are idle. Production stops, but the payroll and overhead go on. It is such emergencies that make business men sit up. The boiler room is in the limelight for the moment. Something must be done to start the wheels.

Under such circumstances it is not unusual to doctor the symptom instead of the disease. The trouble is patched up in the quickest way possible and the machinery again begins to grind out the product. Such a procedure is natural and logical, provided the real trouble is hunted down and corrected at the same time. The chief engineer no doubt asks for an appropriation to put the boiler room into proper shape. No doubt he meets with little or no success. At the same time he is expected to keep the mill running. In the majority of cases, therefore, the matter is dropped and forgotten until there is trouble again, and then the process is repeated.

It requires no argument to show that such methods do not conform with sound engineering principles. Engineering is, moreover, a combination in varying proportions of business, common sense and a knowledge of certain natural laws. It is evident, therefore, that engineering and business are closely related, and that if a proposition is unsound from an engineering standpoint

it is also unlikely to stand the acid test of the requirements of good business.

One of the hardest tasks of the engineer, however, is to convince the business man of this very fact. Usually the trouble lies in the fact that the engineer is not broad enough to see the business as well as the engineering angle of the problem. It is obvious, of course, that if the engineer himself cannot see it clearly he cannot explain it to another, least of all to a man who is more or less ignorant of anything but dollars and cents. It is quite natural and logical for the business man to shy at the engineer's recommendations, especially when they involve the outlay of considerable money. Perhaps he has previously followed some quack engineering advice and was badly taken in.

There are many cases of this sort, and a large percentage of them arise because the business man has turned a listening ear to some prosperous salesman who was more of an orator than an engineer.

It is not usually advisable to talk to him about pounds of steam per pound of coal and percentage of CO_2 in the flue gas. These ideas are not in his everyday vocabulary. The capable engineer will show him in dollars and cents where he is wrong and how he can do better. In discussing engineering problems with the business man you may always be sure of one thing: He wants to make money, and he will do any reasonable thing to increase the profit per unit of his product. If the engineer is big enough and broad enough he will soon learn this secret. He will learn the other fellow's langauge and he will win out.

A particular boiler plant consisted of five boilers of B. & W. and Stirling types, having a total rated capacity of 1550 hp. One, a 350-hp. B. & W. unit, was equipped with a mechanical stoker, while a second stoker had been ordered for one of the 350-hp. Stirling boilers. It was expected that these stokered units would develop 200 per cent of their rated capacity for a period of 4 hr. As a matter of fact, the stokered boiler could not develop 150 per cent of rating for 4 min. In fact, this unit could not be operated at rated capacity without serious furnace pressures and consequent deterioration of brickwork and equipment. Moreover, none of the boilers in the plant could be operated at rating without experiencing pressures over the fire. The normal load of the plant demanded as much steam as the boilers could evaporate under the bad operating conditions. It was a 24-hr. plant. There was no such thing as a spare boiler, and as a consequence the boilers received only such care as could be squeezed into a Sunday's work.

The question of the proper care of the equipment became acute and the desirability of a spare boiler was evident to all. At length it was decided to place an order for a new 350-hp. Stirling boiler to serve as a standby.

At this time the writer became actively interested in the operation of the boiler room and equipment. A rapid mental analysis of the problem was something like this: It was desirable to increase the capacity of the plant so that it would be possible to operate with one spare boiler. On the other hand, it was evident that the present equipment was being operated far below the rating of the boilers, roughly at about ½ of the rating as an average and about ¾ on peaks. If these boilers, therefore, could be brought up to rating it would then be possible to carry the load on the present equipment and to have one spare boiler.

To evaporate a larger quantity of water, however, means the burning of more coal, which in turn means the forcing of more air through the firebed. It is evident, moreover, that air cannot be forced through the bed any faster than the gases of combustion can be carried away by the stack draft. In other words, the stack must be sufficiently high to carry the gases from the boiler as fast as they are generated or a pressure will be built up in the furnace and the gases will be forced out into the boiler room. This is just what was taking place.

Good engineering practice, therefore, demanded a new stack rather than a new boiler. The problem now was to get this idea across to the business men who would want to know why they must spend $15,000 for a new stack and breeching instead of only $10,000 for a new boiler, as had been originally proposed. This is the way the problem was handled. These men knew very little about available drafts, draft losses or inches of water. As a matter of fact they were not interested in a theoretical discussion of combustion rates. But they were vitally interested in getting out their product for a minimum cost. They were also interested in anything to avoid shut-downs and to increase production. And when they bought material they were interested in getting the material for the least unit cost. You can talk with these men along these lines all night and they will listen interestedly. They understand you.

In this case it was estimated that a new stack large enough to enable the stokered boilers to be operated at 200 per cent and the hand-fired boilers at 125 per cent of their rated capacity would cost in the neighborhood of $15,000, together with the breeching. The available capacity of the plant would be increased from 1160 to 2460 hp., or about 1300 hp. This figures about $11.50 per hp.

The proposed new boiler was to be rated at 350 hp., but with the old stack it would have been possible to get only ¾ of its capacity. It would therefore add but 260 hp. to the plant. Since the contract price for the boiler and setting was in the neighborhood of $10,000, the company would have been paying for their added capacity at the rate of $40 per hp.

When the problem was put up to the business men on the basis of unit costs they could understand that a new stack was giving them the equivalent of nearly four new boilers. They didn't care so much for the engineering niceties connected with the deal. They saw they were making a good buy. That was enough.

The engineer today is continually thrown into intimate contact with the business man, and it is up to him to learn the business language. Every engineering problem has its business angle. The success of a manufacturing enterprise may depend upon the way in which its engineering problems are solved. But if these engineering problems lose out by default simply because the engineer has been unable to present them clearly to the business man, then the solution has been in vain. It is the duty of the engineer not only to solve these problems, but to be able to present them to the business man in such a way that he will see equally clearly the importance of the problem and the accuracy of the solution.

Eliminating Wastes of Exhaust Steam

EMPLOYMENT OF DUAL DRIVEN AUXILIARIES WITH STEAM END UNDER THERMOSTATIC CONTROL INSURES EFFICIENT UTILIZATION OF EXHAUST

CONSIDERABLE economy of operation is realized at the new Cromby Station of the Philadelphia Suburban Gas and Electric Co., Phoenixville, Pa., by the use of a dual system of drive employed in connection with exciters and condensers. Each of these units is provided with a steam turbine and an electric motor. Heating of the feed water is accomplished exclusively by means of the exhaust steam from the turbines; but as the amount of such steam is frequently in excess of that required, provision has been made whereby the turbine is automatically cut out of service and the electric motor into service upon the temperature of the feed water reaching a pre-determined value.

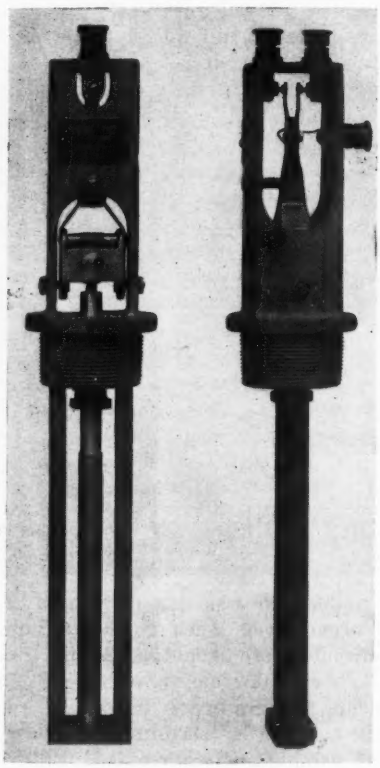


FIG. 1. FRONT AND SIDE VIEWS OF TEMPERATURE CONTROL THERMOSTAT INSTALLED ON HEATER

To care for this operation the feed-water heater is fitted with a thermostat, Fig. 1, which is electrically the equivalent of a single-pole double-throw control switch with the sensitive elements immersed in the feed water.

The contacts on the thermostat, as indicated in Fig. 2, control a double coil relay. When the thermostat moves to either end of its travel it opens or closes the contacts of the relay by energizing one or the other of the two coils. Auxiliary contacts on the relay open the control circuits to the relay coils when the relay has moved from one position to the other, so that the coils of the relay are in circuit but momentarily.

Mounted on the same base with the relay is a magnetic contactor, which is opened and closed by the contacts on the relay, and which opens and closes the power supply to the motor.

If the temperature of the feed water falls the thermostat through the relay opens the contactor, cutting off power to the motor, and when the temperature of the feed water increases to a definite amount the reverse operation takes place and the motor is connected to the supply lines.

The governor on the turbine is set to operate at a speed slightly lower than the full load speed of the induction motor. With such a governor setting, if the set is driven by the motor the speed of the set rises a trifle above the speed at which the turbine governor is set, and as a consequence the turbine valves automatically close, for the reason that the turbine is running slightly above its no-load speed. Driven by the motor, no exhaust steam is available for heating the feed water, and

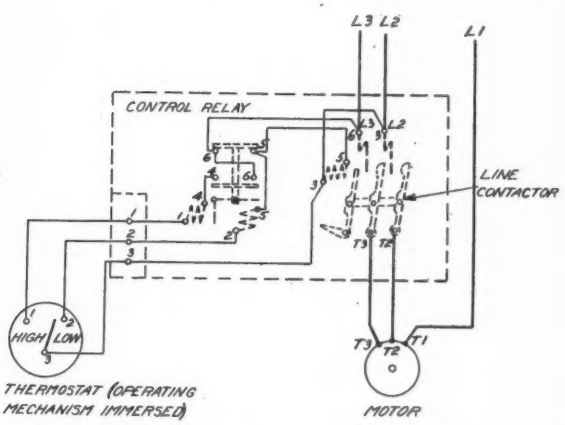


FIG. 2. DIAGRAM OF CONNECTIONS SHOWING METHOD OF CONTROLLING OPERATION OF AUXILIARY MOTORS

as a consequence its temperature falls. The thermostat will then move to the other position, open the contactor and cut off the power to the motor. The speed of the set will drop slightly until the governor on the turbine opens the valves, when the turbine will take up the load, and its exhaust steam will therefore heat up the feed water.

When the temperature of the feed water increases sufficiently the reverse operation takes place, the motor picks up the load, the turbine valves are closed and no further exhaust steam will be available for heating the feed water.

THE PRUDENT penniless beginner in the world labors for wages a while, saves a surplus with which to buy land or tools for himself, then labors for himself another while, and at length hires another beginner to help him. This is the just and generous and prosperous system which opens the way to all, gives hope to all, and consequent energy to progress and improvement of condition to all.—ABRAHAM LINCOLN.

Graphite for Boilers

EVERYBODY who has run a boiler knows the evil of scale and the "cussedness" that it brings into the day's work. Scale sneaks its way into even the best regulated plants, and some means must be found to remove it.

One method that has shown good results is the injection of graphite with the feed water. Being a mineral, graphite has no chemical action on either water or metal, nor is it affected by chemicals in the water. Its action is mechanical, the fine particles of graphite working through the fissures in the scale and penetrating gradually between the scale and the metal, thus loosening the scale so that it is easily removed. If the scale is hard and is fast to the metal the process may require some months; but once removed, the scale will not again adhere closely to the metal so long as graphite treatment is used. New scale formed will be mixed with graphite, so that it is soft and easily cleaned out. While the boilers must still be cleaned, the time and labor required will be greatly reduced, and because of this, more frequent cleanings will be possible, thus maintaining better efficiency and reducing repair bills.

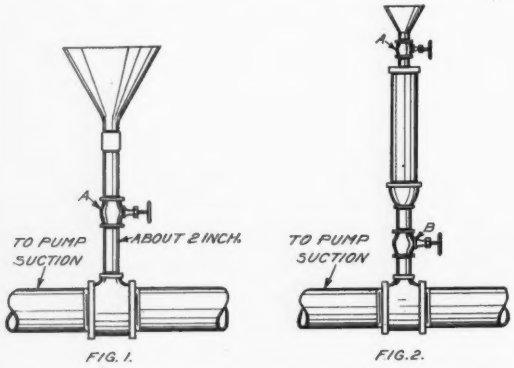


FIG. 1. DEVICE FOR FEEDING BOILER GRAPHITE INTERMITTENTLY

FIG. 2. ARRANGEMENT FOR FEEDING GRAPHITE TO BOILERS CONTINUOUSLY

As the graphite particles have to penetrate into small fissures, a fine graphite is essential. The amount required will depend on the purity and on local conditions, and should be determined by experiment, but as a schedule for a first start one manufacturer gives the following data: For a run of 12 hr. use 1/5 pint for each 50 boiler hp. This will be approximately 1/6 lb. per 100 hp. for a 10-hr. run.

After all old scale is removed, a slightly less amount of graphite can be used daily; but it is a good plan to put 2 qt. of graphite into the boiler after each cleaning, either allowing the water to distribute it, or swabbing it into the clean metal as a paste with kerosene.

Do not use grease or oil to form the paste.

Feeding Graphite

Graphite may best be fed into the suction of the boiler feed pump. It will improve the operation of pistons, valves and meters and can be so fed with no trouble. The fine graphite should be mixed with hot water, and is then put in by means of a funnel, Fig. 1, the whole dose for a day being fed in a short time through valve A; or a reservoir chamber may be used, Fig. 2, and the valve B cracked slightly, so that the graphite will be fed slowly all day long. The latter method is to be preferred.

If boilers are in a battery, care must be taken that each boiler receives its share of graphite, and it may be better to feed by the former method, shutting off the feeds to all but one boiler, and thus treating each boiler separately.

When cleaning boilers in which graphite is used, they should be cooled down thoroughly before being opened, and washed down immediately on opening with a large hose to remove the sludge while still soft and wet. The sludge will harden as it dries, and it is much easier to wash it off at once than to scrape it off later.

For water tubes, do not take off the caps until ready to turbine them; and put the turbine through as quickly as possible after the caps are removed.

Some scale breaks up quickly after beginning the use of graphite, hence it is important to examine the boiler soon after starting the graphite treatment, so that loosened scale may not be allowed to accumulate where it will cause overheating and damage.

After old scale is all removed, some leaks at seams may appear where joints have been covered with scale. These should be calked, and, of course, careful examination made for cracks, pitting and corrosion that may have been covered with scale. If faults are found, they should be removed, if serious, and steps taken to prevent further injury.

When the old scale is all cleaned out the boiler may be run for somewhat longer periods between cleanings, but sludge should be blown down frequently, and the boiler washed out often enough to prevent accumulations of any thickness in any part of the boiler.

Warming Mills and Other Buildings

By Mark Meredith

THE problem of warming mills or other buildings has often given much trouble. Under ordinary conditions there should be 9 sq. ft. of radiating surface for each 1000 cu. ft. of space for 60 deg. F. when outside temperature is 30 deg. F. If, however, most of the building is "shedding with glass roofs," the amount of heating surface required will be uncertain and might easily work out to double the figure just given, which would be for sound brick walls and a glass area not exceeding 20 sq. ft. per 1000 cu. ft. of space. It is quite impossible to say without fullest details of construction of walls, but it can be said that 1 sq. ft. of heating surface can be allowed for each 16 sq. ft. of glass exceeding 20 sq. ft. per 1000 cu. ft. of space. For required boiler capacity allow 1 lb. of steam for each 2½ sq. ft. of radiation per hour, so that 2500 sq. ft. of radiation would require a boiler capable of generating 1000 lb. of steam per hour with easy firing. It is better to order a boiler in this way than to calculate by horsepower. Remember that all pipe surface, unless very thickly lagged, is radiating surface, and it is always better and more economical to have a boiler of full power.

An Industrial Club

IN THE completion and formal opening of the "Essington Club" another provision has been realized for the comfort and the convenience of Westinghouse employes at the Essington Works, South Philadelphia, Pa.

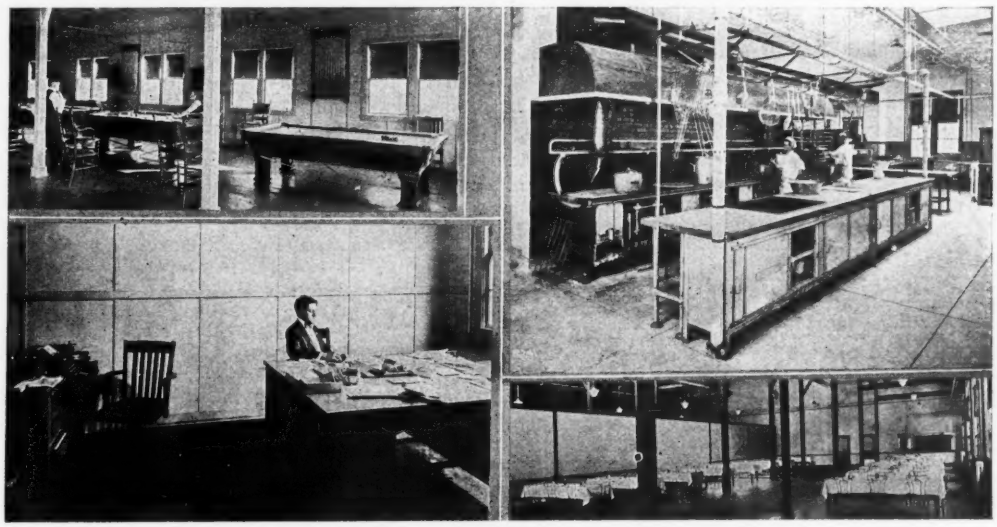
The club is located on the Tinicum road facing the Delaware river front in one of the most picturesque parts of Essington. The structure is built in the shape of a fan, consisting of seven sections. The buildings are two stories high with total accommodations for 500 guests. In the arrangement of the seven sections, the center is occupied by the two large dining halls, kitchen, offices, lobby and porch.

Immediately adjoining the lobby on each side are the recreation rooms, such as library, reading room, chess, checker and card room, billiard rooms, music room and lounging floor. From the center three wings of the fan spread out on each side are set apart for the bedrooms. The club has its own heating and lighting plant, and each separate section has its own baths, lavatories and shower baths.

Operation of the establishment is in charge of a special management and the service force is in charge of H. M. Larson. Two meals will be served daily, with the exception of Sunday, when mid-day dinner is added to the bill of fare. Bedrooms are not luxurious but are representative of solid, homelike comforts. There are two classes of sleeping accommodations. In the one the guest has his own room completely furnished, whereas in the other the sleeping quarters are divided into separate wards. While in one of the dining halls meals will be served at tables and in the other a quick service system has been established, the food in both will be of the same quality and excellence.

The welfare department is arranging for concerts, social entertainments, scientific and illustrated lectures at stated intervals; and it will also provide magazines, daily papers, and trade periodicals. In the recreation halls will be pianos, victrolas, player pianos and other instruments for the entertainment of the guests.

Owing to the convenient proximity of the Delaware river, the water front will, by next spring, be transformed into a park with boat landings and camp buildings for the accommodation of canoe and fishing clubs.



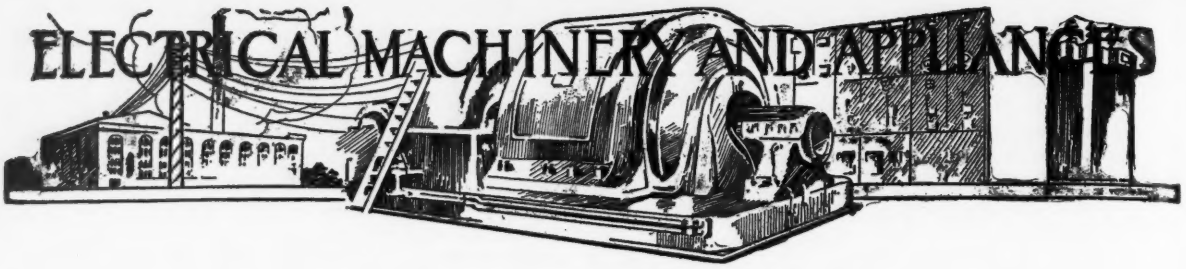
INTERIOR VIEWS OF THE ESSINGTON CLUB

Opportunities for Disabled Men

ANY MAN with one eye, one arm, fair hearing, or one leg off below the knee but capable of easy movement with artificial foot, should be able to qualify for the position of safety engineer or inspector, according to the federal board of vocational education, which is in charge of the vocational rehabilitation of disabled soldiers, sailors and marines. The fact that a great part of the safety engineer's work is in the field and usually in locations where some degree of agility and ability to get about is required, would indicate that men with legs off above the knee would be unable to fill such positions. The one-armed man would be less handicapped for this sort of work than a man with only one eye, or defective hearing, or the loss of one foot.

A course of training for safety engineer should be a minimum of 6 mo., and those wishing to qualify for inspectors should be under training for not less than 3 mo. The chances of employment after training are good, especially for well qualified safety engineers, and the salary of the safety inspector will range between $1200 and $2000 a year, and that of the safety engineer between $1800 and $3000 a year.

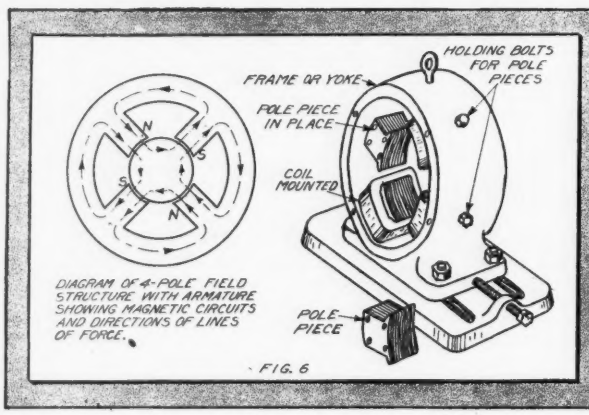
The opportunities for the work are numerous, such officers being employed by insurance companies, by some of the large industrial concerns, as well as by the Interstate Commerce Commission, the inspection service of the various states, and in some cases municipalities offer good positions of this sort. Positions under the Interstate Commerce Commission are subject to civil service examination, and those under the various states to state examination, but those with private companies are subject only to such requirements as are established by the company.



A Study of Dynamo Electric Machinery---II

THE FIELD STRUCTURE; DEFINITION OF MAGNETIC UNITS. BY OTTOMAR H. HENSCHEL

EXCEPT for numerous minor fittings, the ordinary direct-current dynamo consists essentially of a stationary member known as the field structure and a revolving element, the armature. Since the advent of the first machine many forms of field structure have been employed; but today the ring type of frame with inwardly projecting pole pieces, such as shown in Fig. 6, is used almost exclusively. Frames and magnet cores are generally made of soft iron or steel, although in the larger machines laminated iron pole pieces, secured to the frame by means of suitable stud bolts, are employed. Shoes are fitted to these poles to provide a minimum air gap between pole pieces and armature, to insure a more effective distribution of the magnetic flux and to serve as a means of securing the field coils.



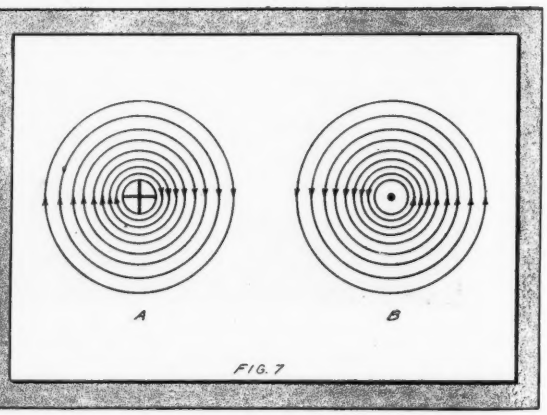


FIG. 6. COMMON FORM OF FIELD STRUCTURE WITH INWARDLY PROJECTING POLE PIECES
FIG. 7. DIRECTIONS OF LINES OF FORCE SURROUNDING CONDUCTORS CARRYING AN ELECTRIC CURRENT

MAGNETIC UNITS

AS THE AMPERE is the unit of electric current, so is the line of force the unit of magnetic flux. It is an arbitrary value, being defined as that amount of flux, which, when cut or sheared by a conductor within 1 sec. of time, will induce within that conductor an electromotive force of 1/100,000,000 volt.

To create and maintain a magnetic flux, however, a magnetomotive force analogous to electromotive force or voltage in an electric circuit is required, and as the flow of current in any electric circuit is opposed, or resisted, by the resistance of the conductor, so is the flux or the lines of force in a magnetic circuit resisted by the reluctance of that circuit. The relation between flux or lines of force, magnetomotive force and reluctance is similar to the relation between current, electromotive force and resistance as expressed by Ohm's law. We then have magnetomotive force equal to the product of flux and reluctance, or flux equal to magnetomotive force divided by reluctance.

When carrying an electric current, a conductor is surrounded by a magnetic field, the strength of which is dependent upon the current flow with the direction of the lines of force dependent upon the direction of current flow. If, as at (A), Fig. 7, we allow the inner circle to represent the section of a conductor with the current passing downward through the plane of the paper, as indicated by the cross or the tail of an arrow, the direction of the flux or lines of force will be clockwise, while if the flow of current is in the opposite direction, or upward from the plane of the paper, as at B, the lines of force will travel in a counter-clockwise direction.

By wrapping such a conductor around a cylindrical piece of magnetic material, such as soft iron or steel, preventing electrical contact between the two, the lines of force incircling the conductor will induce within the piece of iron or steel—the core—a magnetomotive force, which in turn will establish a flux in the manner indicated in Fig. 8. The degree of magnetomotive force thus created is dependent upon the product of the number of amperes of current flow through the conductor and the number of turns or times the conductor is

wrapped around the core, or, in other words, the number of ampere-turns. If the conductor is wrapped about the core 5 times and carries 20 amp. of current, the number of ampere-turns is equal to 100, although this same number of ampere-turns is obtained when the conductor is wrapped about the core but twice and carries 50 amp., or if 10 turns are employed and a current flow of 10 amp. maintained. In each case the product or number of ampere-turns is 100.

The practical unit of magnetomotive force is the ampere-turn and may be represented by the following formula:

$$M = I \times T$$

where M is the magnetomotive force in ampere-turns, I is the current flow in amperes, and T the number of times the conductor is wrapped about the core.

When a magnetomotive force of 1 ampere-turn produces in a magnetic circuit a flux of 1 line, the magnetic circuit in which this is produced is said to have a reluctance of 1 rel, which is equivalent to the reluctance of a prism of non-magnetic material having a length of 3.19 in. and a sectional area of 1 sq. in. The rel is represented by the letter R.

Another property of magnetic circuits requiring consideration is permeance, the reciprocal of reluctance and properly defined as the ease or readiness with which flux may be developed. The unit of permeance is the perm and is represented by P or $1 \div R$.

Substituting permeance for reluctance in expressing the relation between magnetic flux, magnetomotive force and reluctance we have:

Flux = Permeance × Magnetomotive Force.
Permeance = Flux ÷ Magnetomotive Force.
Magnetomotive Force = Flux ÷ Permeance.

Magnetizing Force

In an electric circuit consisting of a conductor of uniform sectional area a drop of electromotive force occurs, which for convenience may be expressed as so and so many volts drop per 100 ft., or, if so desired, per foot. Similarly in a magnetic circuit a drop of magnetomotive force takes place. This drop, referred to as the magnetomotive force gradient, or magnetizing force, and represented by the letter H, may be defined as a quantity indicating the magnetomotive force expended per unit length of the magnetic path.

The unit of magnetomotive force is, as we have learned, the ampere-turn, the symbol of which is the letter M. If, therefore, we have a magnetic path of length l, the value of the magnetomotive force gradient, the magnetizing force or H, may be readily determined by dividing M by l. Transposing this equation, we may

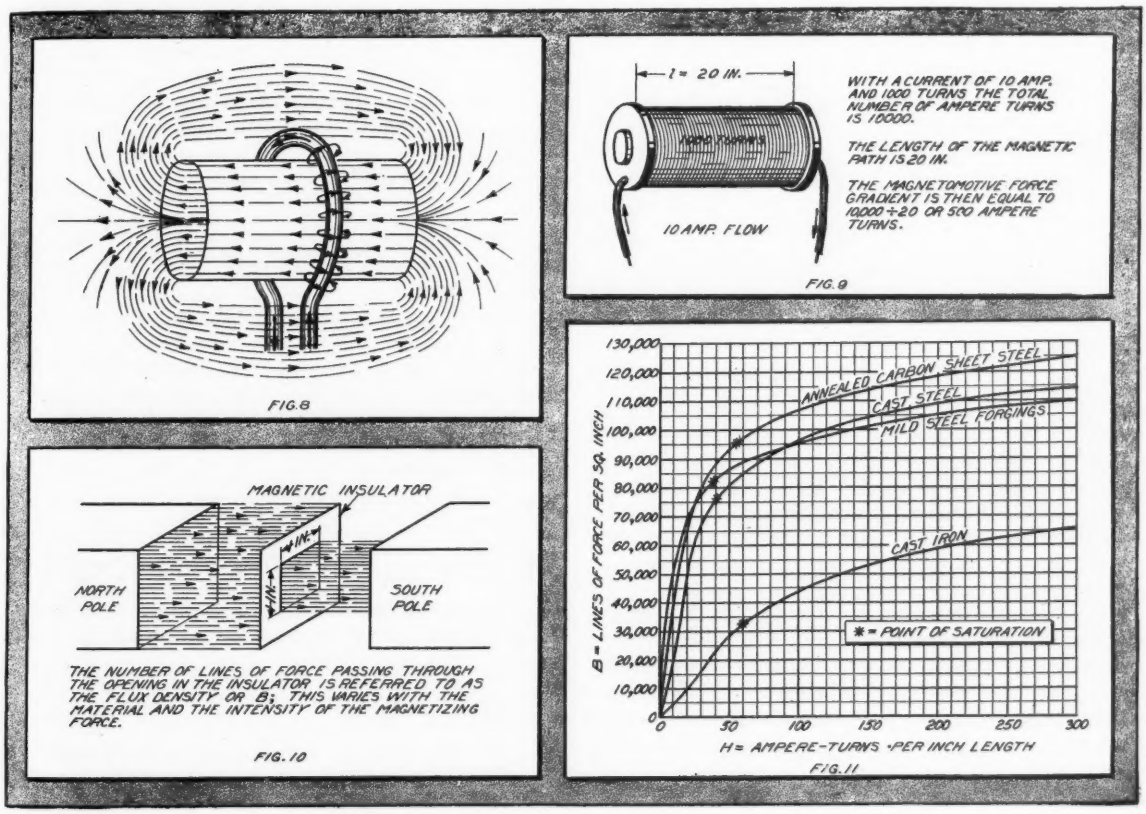


FIG. 8. BY PLACING AN IRON CORE WITHIN A LOOP OF WIRE CARRYING AN ELECTRIC CURRENT MAGNETIC INDUCTION WILL BE SET UP IN THIS MANNER

FIG. 9. MAGNETIZING FORCE IS EQUAL TO THE AMPERE TURNS DIVIDED BY THE LENGTH OF THE MAGNETIC PATH

FIG. 10. AN EXAMPLE OF FLUX DENSITY

FIG. 11. MAGNETIZATION CURVES FOR VARIOUS MAGNETIC MATERIAL

solve for M or l, the former being equal to the product H and l, while l is equal to M divided by H.

On an iron core, having a length of 20. in., and as shown in Fig. 9, is wound a coil, consisting of 1000 turns of wire through which an unvarying current of 10 amp. is caused to flow. The total number of ampere-turns, M, is equal to the product of the number of amperes flow, 10, and the number of turns, 1000, or 10,000.

The length of this core is 20 in., so that the value of H or the magnetomotive force gradient may be obtained by dividing the total number of ampere turns M or 10,000 by the length l or 20 in., giving as a quotient 500 ampere-turns per inch length.

Flux Density

For sake of convenience the direction of lines of force is always assumed to be from the north pole to the south pole of a magnet. If, therefore, as in Fig. 10, it would be possible to place within the space between the north and south poles a magnetic insulator or shield having an opening 1 in. square and capable of cutting off all of the magnetic lines of force tending to pass from the north pole to the south pole, except those passing through that opening, we would create a path for these lines of force having a sectional area of 1 sq. in. The number of lines of force passing through this opening would then be referred to as the flux density, the symbol of which is the letter B.

Knowing the value of the total number of lines of force, the flux density or B may then be obtained by dividing this by the sectional area of the magnetic path A in square inches, or B is equal to F divided by A. Transposing, we may obtain the value of F by the multiplication of B by A or, if the value of A is desired, divide F by B.

Permeability and Reluctivity

Magnetic permeability represented by the letter u expresses the ratio of the magnetic flux density to the magnetizing force, or u is equal to B/H. Permeability is generally called specific permeance.

Reluctivity is the reciprocal of permeability and is represented by v; it is specific reluctance. Unit reluctivity is that through which unit magnetizing force will establish unit flux density.

Magnetic Saturation

Just as a sponge will absorb but a given amount of water, so is it possible for all practical purposes to produce but a limited flux density or number of lines of force per square inch section of magnetic circuit. Up to a given point called the magnetic saturation point increase of flux density for various materials varies with the magnetizing force H in the manner indicated in Fig. 11. Beyond this point, however, the curves approach the horizontal so that the comparative increase in flux density does not warrant the expenditure of the magnetizing force required to produce it. We note from these curves that the point of magnetic saturation for cast iron is about 32,500 lines per square inch; for cast steel it is approximately 77,000 lines, and for mild steel forgings and annealed carbon sheet steel about 83,000 and 95,000 lines per square inch, respectively.

(To be continued.)

Automatic Control for Electrically Driven Pumps

THERE ARE many troubles which may arise in an electrical connection between an electrically-driven pump and the reservoir, a point at which the water is used, if the two be far apart; but the Wolf apparatus as installed at Schweinsburg on the Pleisse in Saxony has proved satisfactory and has since been used in other places. The arrangement comprises a direct-driven centrifugal pump with electric motor on the same base-plate. A large air vessel is fixed on the delivery pipe close to the pump, and on the top of the air vessel there is a switch with flat springs. At the other end of the delivery pipe is fixed a special closed, cylindrical tank provided at the top with a small fitting, having an air pipe of small diameter. If the storage tank be emptied down to a point just above the delivery pipe, which is connected to the side near the bottom, then the pressure upon the spring on the air vessel is relieved and the starting switch is closed in the case of small plants; but in larger plants a relay is closed, which in its turn actuates the starting switch. The pump works until the storage tank is full, when the increased head of water forces the spring in and opens the switch again on the air vessel. The air pipe serves to let the air out and in from the tank. A large pumping plant for the locomotive feed water at Meusewitz Sachsen-Alternburg is fitted with the Wolf control. The distance between the pump house and the storage reservoirs is 800 ft.; the volume delivered is 3450 gal. per hour; the height to which the water is raised, inclusive of friction, is 108 ft.; the motor requires 3.7 and runs at 1450 r. p. m.

Renewing Collector Ring Surfaces

Appliance for Resurfacing D.C. Commutators Works Equally Well on A. C. Collector Rings

FOR many years it was taken for granted that when the commutator started to spit and spark and showed evidence that it was in need of being dressed up, the only thing to do was to shut down that equipment, remove the commutator and turn it down in a lathe, or temporarily tide over the trouble by using sandpaper. A Chicago man decided, however, that there must be a short cut out somewhere and set about to find it.

In determining the qualifications of the simplest and easiest way of doing this, he figured that the work should be done, first, while the motor was in service, and, second, by some inexpensive medium. Experiment finally brought forth a non-conducting composition which, when molded and hardened, presented a continuous abrasive surface that by simple contact with the commutator while in rotation would cut down the mica ridges and bars easily and quickly. Of course, the resurfacer immediately appeared on the market.

For awhile a.c. equipment was not considered, but as the work of the resurfacer became known the demand for an equivalent device to be used on collector rings began to be felt, and Mr. Becker went to work on the problem. It was the old story of Houdini, the jail-breaker, and the small town jail. Houdini claims that

only once in his life was he really stuck. He was put in a cell in a small town to make good his boast that he could escape from anything in ten minutes. After working on the lock of this particular cell for 4 hr., it suddenly dawned on him that the constable had forgotten to lock him in, and that to get out, in the first place, all he would have had to do was to turn the knob.

And so it was with the problem of resurfacer for collector rings. The same appliance that does the on the d.c. commutators can be used on the a.c. collector rings. So those who have both a.c. and d.c. equipment can use the same resurfacer for both if it is of the right size.

What Can Be Done to Improve Electric Arc Welding?

By J. M. Jardine

THIS great war has surely benefited the electric arc welding industry—that is, a great many new applications have been found; this alone has opened up a field that was never expected, and possibly would never have been developed had it not been for the war.

In the shipbuilding program of the emergency fleet corporation electric arc welding surely did its little bit to help win the war; not only has electric arc welding helped the output of ships, but in turn a higher class of operators have been made, which will eventually benefit the electric arc welding industry at large. This is due to the fact that schools for the instruction of operators were maintained at the various plants where electric arc welding equipment were manufactured.

The question of efficient operators means more to the electric arc welding progress than anything else; this, in the opinion of the writer, is the reason why electric arc welding is not more extensively used.

The reason for this condition can be blamed on several causes; the manufacturers themselves are somewhat to blame, inasmuch as they have advertised the electric arc welding as a laborer's job; the writer believes this to be untrue. No firm can afford to allow welding done other than by an intelligent and efficient operator.

The reason for bringing this point out so strongly is to try to convey a message to the user. If he will just take a few minutes away from his regular routine of business and let his mind concentrate on what he is accomplishing in his welding department I believe he will find (that is, in 90 per cent of the cases) that the welding is being left entirely at the mercy of the operator, and in most cases the attitude the operator takes is, so long as the welded portion is covered, showing no outside fracture, it is all right; in steel foundries it is common practice for the operator to strike an arc (graphite method), hold it at the point to be welded until the metal becomes molten, then add the filler without even attempting to see that all points are amalgamated in a molten state, or even to clean out the weld. The latter is the cause of a great many complaints on hard welds; as a matter of fact, a good operator can make a graphite weld perfectly soft; however, if an operator leaves slag in the weld, it is only to be expected that a tool striking the part welded is going to stall.

The second big drawback to electric arc welding, as compared with oxy-actylene, is that the manufacturers of the latter equipment are continually making a profit on the sale of gas and air, and are enabled to give very good service, keep a watchful eye on the general run of operators, and give quite a little assistance, which benefits them in return.

On the other hand, the firm that sells an electric welder invariably ships the machine to the purchaser, and leaves him to fight out his own salvation. Possibly two or three firms do give to the customer a few days' instructions; this helps considerably, but it isn't all that should be done. For instance, a demonstrator will go on a job, break in a man and see to it that before he leaves the prospective operator is made of promising material; yet it often happens that when the man who is given the instruction reaches the point where he thinks he can hold a higher priced job down he quits, and once more a green man attempts to hold down the job that a welder should be handling.

Some manufacturers of electric welding equipment are doing their utmost to assist the user in making his welding profitable and efficient, and have a service man at each district office well qualified to give service that will help bring about the desired results. They also maintain a welding department at their factories, where any firm can send one of their men to receive a thorough course in the art of electric arc welding.

The Hydro-Electric Resources of Italy

By Guido Rossati

IN 1847 Richard Cobden, while visiting Massimo d'Azeglio in Rome, and discussing with him the economic disadvantages of Italy on account of her lack of coal, to d'Azeglio's query "What can Italy do without coal?" retorted, pointing to a cloud in the sky; "There is your steam." Cobden, by this answer, foreshadowed the great possibilities of Italy for water power development.

The oro-hydrographic configuration of Italy is favorable to the creation of important hydraulic energies. Especially so in the southern watershed of the Alps, feeding its numerous rivers and lakes, with means of regulating the flow and fall of water so as to produce hydraulic energy of continuous potentiality, at convenient cost.

Numerous plants have been established; many of considerable importance, such as the Adamello, generating from a fall of 3000 ft., 20,000 hp., at 60,000 volts conveyed to Milano, a distance of 68 miles; and likewise the Tirano plant, conveying a similar amount, at 40,000 volts, a distance of 95 miles. To the original 2000 hp. of the Anglo-Roman Co. were added, with the Terni-Rome plant, 30,000 hp. at 75,000 volts, transmitted over 47 miles. The Grossotto plant, in Valtellina, increased by 32,000 hp., at 55,000 volts, carried nearly 100 mi. distant, the Milan supply; and the Italian Electro-Chemical Co. has since transported from the Abruzzi to Naples, over a distance of 112 miles, 24,000 hp. at a tension of 85,000 volts.

These are but a few examples of Italy's hydro-electric plants, established by over 40 different concerns, representing a capital, from a maximum of 65 million to a minimum of 5 million lire; with instances of a maximum total generating power capacity of 100,000 hp., several

from 50,000 to 75,000 hp., and many from 25,000 hp. upwards.

Electric energy in Italy shows for the decade beginning 1898 an increase of 665 per cent, from 86,750 to 511,000 kw., of which 360,000 hp. was hydraulic. It had increased in 1916 to 1,064,000 hp. This represents but a small part of the available resources of Italy, estimated at a total of 5,000,000 hp., of which about 3,000,000 are already in course of development, and the balance yet to be planned.

Before the war, the Germans, through the Allgemeine Electricitaets Gesellschaft, secured a hold on Italian industry, but, since the outbreak of the war, the Italian government has not merely broken the Teutonic hold, but has proceeded with an active water-power policy. Concessions for 208,000 hp. were granted in 1917, and, in December, 1917, 218 requests were under examination for concessions estimated at 816,000 hp.

Some of the plants planned for the future contemplate an expenditure of 65 million lire for three artificial lakes in the Sila district of Calabria, to supply 150,000 hp. and another outlay of 25 million lire for the Tirso reservoir in Sardinia, having a shore line of 40 miles.

The railroads in Italy are gradually undergoing electrification. Among the roads electrified is the Milano-Varsese-Porto Ceresio, operated by the third rail and continuous current system, acknowledged the best for light trains and frequent service, and the Valtellina line, 102 mi. long, operated by the alternate current and high tension system, the same adopted for the 12-mi. tract of the Giovi tunnel, near Genova.

Hydro-electric power in Italy, has, like other important public utilities, entered the province of municipal control. Rome is preparing to operate a 25,000 hp. plant on the Nera river; Milan operates plants in Valtellina for a supply of over 40,000 hp., and Turin the Doira Valley plant at Chiomonte, with lowering cost and increased use of power. It is estimated that the cost has been reduced in 7 years of municipalization by about 45 per cent and consumption doubled.

The plant of the Turin municipality, while one of the most perfect modern types, is small, compared with plants for a total of 100,000 hp. of the Societa 'Lombarda, or the 77,000 hp. plants of Societa 'Conti. The plant of the Societa 'Lombarda at Vizzola Ticino was considered, when built in 1901, the largest then existent in Europe, sharing this honor with the Paderno plant of the Edison Co. of Milano.

In 1912-1913 the total consumption of electrical energy in Italy amounted to hecto-watt-hours, 19,675,971,-267, against 17,868,257,163 in the previous year. Hydro-electric energy is promoting in Italy the metallurgic and electro-chemical industries such as the aluminum, calcium carbide, electro-lyptic soda production, etc.

The after-war period will witness development of domestic workshop labor in preference to factory work, an evolution especially welcome to the war mutilated, and made possible by the easier manner in which electric energy can be distributed in comparison to steam. This will further promote the electrification of Italy, identified, in the South especially, with the irrigation necessary to a more intensified agriculture.

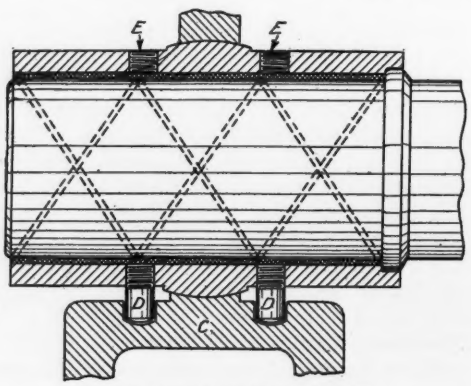
Since the war the Italian government has taken effective measures to prevent monopoly, through priority claims, of the hydraulic energies of the country, by private speculation, and to make their utilization more efficient and of greater revenue to the state, to whom revert the new concessions after a period of 50 yr.

While this industry has stimulated an important domestic manufacture of electrical machinery, engaging the activities of a number of establishments, employing many thousand operators, and turning out high class machines, which have found a market even in America, there is still a field offering wide opportunities to American manufacturers in this line.

An Improvement in Bearings

By J. H. Blakey

WORKING on the theory that the heating of heavily charged bearings, however well proportioned, is most often due to the fact that the weight of the shaft is not distributed evenly on the whole extent of the bearing surface, M. Carl Schurman has introduced some modifications in design which are shown in the accompanying figure, taken from a recent number of Stahl und Eisen. Bearings of this kind have been tried out in various factories in Germany, supporting weights as high as 75 tons, and have shown a marked



AN IMPROVEMENT IN BEARINGS

improvement on those previously in use. The idea is to give the journal box the greatest possible freedom of movement by means of a curved bearing surface above and below, thus allowing for any small unevenness of pressure, caused usually by faulty alinement of the shaft, which must produce heating, no matter how efficient the method of lubrication. In addition to this, holes E, E and D, D, 1/8 the diameter of the shaft, are drilled on opposite sides of the box, and in line. In the position shown in the figure the upper ones are fitted with grease cups, and the lower with studs projecting into holes of slightly greater diameter in the bearing support. When the lining of the bearing begins to be worn the journal box is turned through an angle of 180 deg. and the studs and grease cups are exchanged.

In 1915, D. B. Rushmore estimated the horsepower in use in this country as: Irrigation, 500,000; mining, 6,000,000; flour, grist and saw mills, 1,250,000; factories 25,000,000; central stations, 8,000,000; individual plants, 4,250,000; electric railways, 4,000,000; a total of 49,000,000 hp.; 61.2 per cent of this was steam power, 24.4 per cent water power and 14.3 combustion engines.

Development of Engineer Army Equipment

ENGINEER TROOPS INCREASED FROM 1.6 TO 10.8 PER CENT OF ARMY DURING WAR; RAPID IMPROVEMENT IN EQUIPMENT RESULTED LARGELY FROM RECENT INDUSTRIAL DEVELOPMENTS

AGAIN and again during the recent war the successes of armies were attributed to some achievement of the engineers. These achievements were not alone in the Engineer Department of the Army, but many of them came from civilian engineers in the regular work of their industry. The rapid development of engineer materials for the army was made possible by an understanding of such equipment for civilian use which by slight modifications of design was suitable to the needs of the army. In the army, as in civilian life, it was found that specialization gave the best and most desirable results. Specialized engineers were, therefore, selected as the heads of the various engineering sections, with results that have been marvelous.

It is not the purpose of this short article to go into all the activities of the Engineer Department, but we have obtained information on some of the accomplishments and have chosen a number of devices for description which we believe will be of particular interest to our readers. A summary, however, of the duties of the Engineer Department will aid the reader to a better understanding of this particular division of the army.

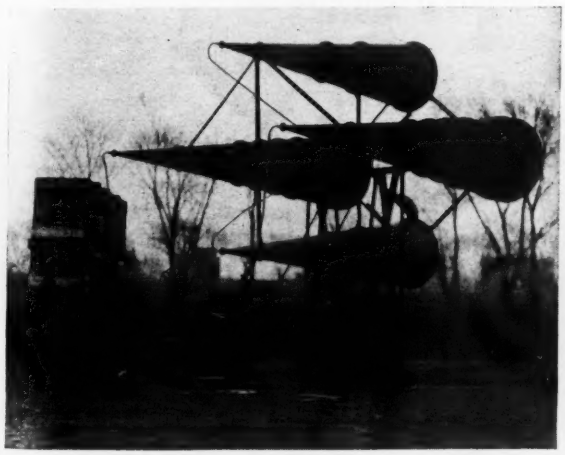


FIG. 1. LONG HORN SOUND DETECTOR DEVELOPED IN THE UNITED STATES

Throughout the war the Engineer Department was charged with the organization and training of engineer troops, and during the major part with the purchase, storage and supply of engineer materials, equipment, etc. The organization of the department was such that it not only used the materials, but could also, through its immediate control over their production, readily suit these materials to the particular uses for which they were needed. For operations in the field this factor is of great importance, and as a result of the needs in this direction the Engineer Department has actively engaged in the development of new equipment and materials.

It is interesting to note that Engineer troops formed only 1.6 per cent of the army in April, 1917, but had been increased to 10.8 per cent by November, 1918. It is also to the credit of this department that the percentage of Engineer troops in France was about 20 per cent greater than that of the army as a whole. They grew to a number 131.5 times their original strength at the beginning of the war.

A typical example of how equipment for civilian pursuits may be transformed into war equipment is the armored railroad car, which was developed for use along the Mexican border where the railroads were liable to attack from small raiding parties. These cars mount four machine guns and a 3-in. rifle, or four machine guns and a searchlight. They are self-propelled and armored; they do not serve the purpose of tanks, but in this war were requested for use along the Jersey coast where raids from submarines were feared.

Narrow-gage railway equipment, so much used around industries in this country, was used in great quantities at the front. The cars are small, the tracks can be readily camouflaged and quickly laid, the locomotives are run by gasoline where smoke would bring the enemy's fire, and the cost for hauling is about 1/7 that of trucks.

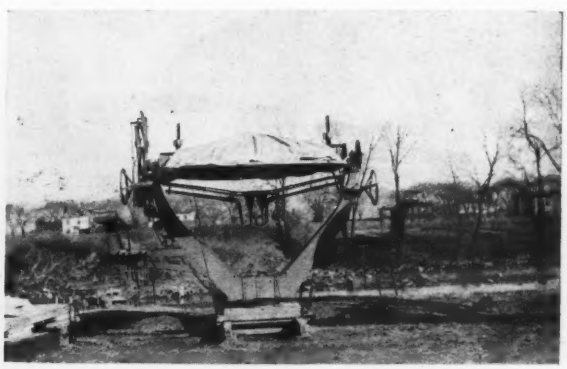


FIG. 2. THE FRENCH PARABOLOID

Not only was narrow-gage railway equipment used in great quantities, but an immense amount of standard-gage tracks, locomotives and cars were shipped to France. To facilitate shipment and rapidity of getting the locomotives into service abroad, locomotives were completely assembled in this country, hoisted as a unit to the holds of the ships, where, together with their tenders, 30 to 36 were packed in baled hay. Unloading was done in a similar manner, so that no time was lost in getting them into operation. Thirteen hundred and three consolidated standard-gage locomotives were shipped to France. It is stated that France was paying $51,000 apiece for similar locomotives, but the engineering and business skill of the Americans in revising specifications to suit manufacturing conditions brought the cost down finally to $37,000 apiece.

Forestry operations of Engineer troops in France will serve to illustrate the rapidity with which our men worked to supply the needs of the army. In October 50,000 board feet of lumber were sawed by these troops, and plans were under way for an output of twice that

amount monthly by January, 1919. The cord-wood output for October was 80,000 cords, and the standard-gage railway ties produced in France would build a line of single-track railway 1091 mi. long.

The manufacture of camouflage material and the design of camouflage coverings for gun mounts, roads, railways, sniper suits, loopholes, observation posts, etc., was part of the duties of the Engineer Department. It is interesting to know that a camouflage factory at Dijon, where 100 soldiers and 900 French women were employed, produced 50,000 sq. yd. of camouflage cover daily. The operations of the armies practically exhausted the supply of burlap in Europe and the United States. A more economical material, however, was developed in this country to replace it.

For the use of technical engineer troops, special truck bodies were developed which enabled these troops to make rapid repairs at the front. Equipments were provided for carpenter, blacksmith, machine shop and lithographic truck bodies. The bodies are mounted on trucks for rapid transportation, but may be removed if the

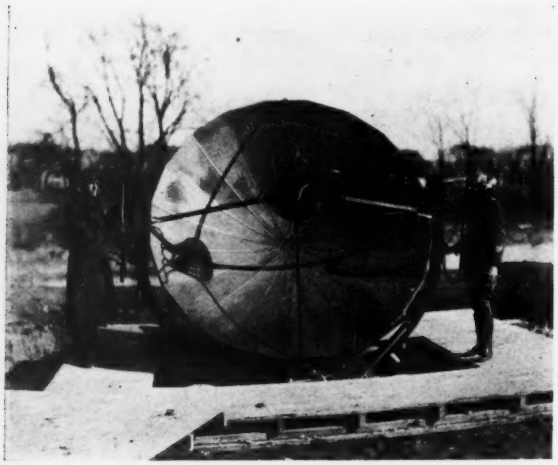


FIG. 3. AMERICAN PORTABLE PARABOLOID

location is not in imminent danger, thus releasing the truck for other service. The machinery is located in the center of the body and the sides and end are dropped to provide a working floor for the men. The equipment in each case is complete and the average power plant would find about all its needs for making repairs in the three shops furnished these organizations.

The building of bridges, of course, was part of the work of the Engineers, and several types were developed, among which were portable steel, heavy ponton and portable foot bridges. The steel type was made up in sections ready to be transported on trucks to the location where needed, and so designed that they could be bolted together. They are capable of carrying 30-ton tanks.

Ponton bridges were so designed as to carry loads of 15 tons on one axle and a crew of 30 men in addition, making them capable of carrying the heaviest mobile artillery in France. The Engineer Department has under developed a raft made of ponton material capable of carrying a 30-ton tank.

One of the interesting designs of foot bridges developed by an Engineer officer in France is made of light material supported on boats made of canvas stretched on wooden frames; duckboards form the floor.

Among the interesting developments of the Engineer Department are the sound-detecting apparatus and searchlights used in defensive work against airplanes at night. The method of procedure in this work is as follows: When an observer hears an airplane, the direction from which the sound comes is located with a sound detector; two or three readings are taken at definite intervals of time, the probable location at the end of the next time interval is then plotted and a searchlight is flashed in that direction just long enough to locate the machine. Quick work is required, as the airplane travels rapidly and may suddenly change its course at any minute. To carry on these operations so that the lights do not serve as guides to the enemy it is necessary to move their positions frequently. The equipment must therefore be highly portable. Numerous developments in this material to meet field conditions show how rapidly improvement took place.

The sound detectors consist of several types. One, a stationary type, consists of four horns, two in a vertical

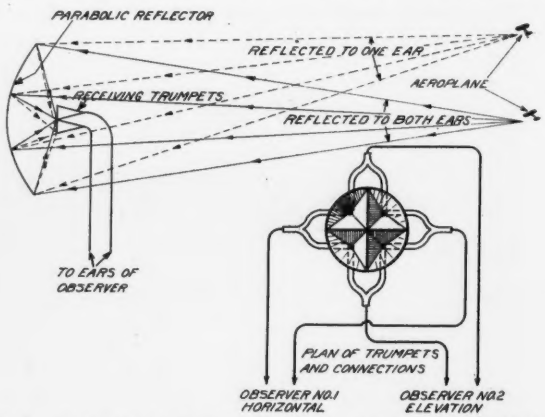


FIG. 4. DIAGRAM SHOWING OPERATION OF SOUND DETECTOR

and two in a horizontal plane. These were mounted so as to permit rotation on a horizontal shaft and turning on a plain table, the whole being supported on a steel tower structure not easily moved and quite prominent target for the enemy. This type has the advantage, however, that it is very accurate and will magnify the sound so that the operators can hear a watch tick 150 yd. away.

The French also developed a paraboloid which has a parabolic surface made of plaster of paris with cast-iron backing 10 ft. in diameter. At the focal point of the paraboloid are four small horns which catch the sound reflected by the parabolic surface and convey it to the ears of the operators through flexible tubing. This device is very heavy, not mobile and does not greatly magnify the sound, but is an improvement on the horn type in that it is less conspicuous.

The latest development is a paraboloid made of beaverboard construction, carried on light steel framework and mounted on chassis of the Ford type. The principle of operation is precisely the same as that of the French paraboloid, but it is light in weight and easily transported from place to place as necessity demands.

To operate these machines two men are required, one to determine horizontal directions, the other angular

FIG. 8. MOSAIC MAP OF SECTION OF WASHINGTON MADE WITH BAGLEY CARTOGRAPH

elevation. Each operator has a tube to each ear; when the paraboloid is set directly upon the airplane the operators get the sound with equal intensity in both ears, when off in one direction that operator gets the sound with more intensity in one ear than in the other. The diagram shows the arrangement of horns and parabolic surface and how the sound is reflected.

The development in searchlights is even more marked than that in sound detectors. At the opening of the

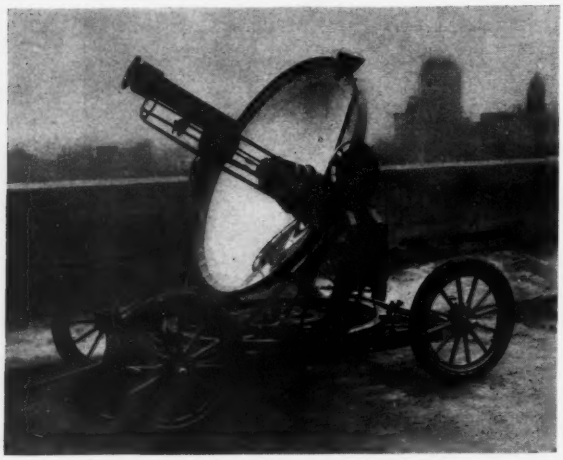


FIG. 5. DISHPAN TYPE PORTABLE SEARCHLIGHT

war the army was equipped with 60-in. sea-coast lights and a few portable searchlights mounted on trucks for field use. The sea-coast lights were the largest lights known, cost about $10,000 and weighed 75,000 lb. From this was developed a portable light equally powerful, costing $2500 and weighing only 900 lb.

The high intensity barrel type light is a self-contained unit, current being supplied by a 25-kw. gasoline engine generating set. The light and the generator are mounted

FIG. 6. LOADING SEARCHLIGHT ONTO TRUCK

on separate trailers and may be drawn by animals or caterpillar tractor. A 600-ft. cable is provided, so that the light may be placed at some distance from the power plant.

For defense against airplanes, the 36-in. light was commonly used. The latest development is a 60-in. light, mounted on a chassis of the Ford type construction and can be pushed around by hand to the location desired, but for transferring any distance the light is run onto a truck. The truck used is a standard Cadillas touring car with modified body, and in addition has a 20-kw. direct-current generator mounted on a quill around the propeller shaft which serves as a power plant for the light, furnishing 200 amp. at 105 volts. On both sides of the truck are reels of cable permitting the light to be separated from the truck by 600 ft.

Two particular features of the latest type of lamps are worthy of note. These are, first, the absence of a lense, forming what is termed the dishpan type light, and, second, a metal mirror. These features have greatly cut down the cost and weight, improved the efficiency to a considerable extent, reduced the liability of breakage to a minimum and enable the cool operation of the light.

Another interesting device is the Bagley cartograph machine, which takes three pictures at a time from an airplane, mapping a strip 3½ mi. wide from an altitude of 4000 ft. The series of pictures is readily matched together, making what is termed a mosaic map of the territory over which the airplane has flown, nearly as accurate as a map drawn from surveys. The reproduction herewith is from a section of Washington, D. C., and shows clearly how the prints were matched together.

These few descriptions indicate how engineers have put into use for war purposes what, in the main, has been developed for peaceful industries. We can attribute the rapid development of equipment for war largely to

FIG. 7. SEARCHLIGHT EQUIPMENT READY FOR TRAVEL

the fact that our purposes heretofore were peaceful rather than warlike, and with all minds concentrated on winning the war, the greatest engineers of the country were at work on problems similar to those upon which they have for years been experts. Original designs are always crude. The best designs of 10 yr. ago lack the benefit of recent experience. Manufacturing methods have changed, factory machinery has improved, metallurgists have improved commercial metals.

From the foregoing it is easily seen that the Corps of Engineers, in close co-operation with Engineers in civilian industries, brought its equipment of all sorts to a high standard. As changing conditions in the field required modifications in equipment, the proper man, or set of men, was called upon to make these improvements. By research, close application to detail and experiment, a high degree of efficiency of equipment was maintained.

THE VICTORY Liberty Loan is nothing but a process by which the people of the United States are to be enabled to take up $4,400,000,000 of I. O. U.'s that are coming due very soon.

Tests on Deoxidation of Hot Water*

By F. N. Speller

WITH REFERENCE to corrosion, it is possible to classify any particular water under one of two types which may be distinguished by the terms active and inactive. The quality of activity is not primarily dependent upon the acid, alkaline or neutral condition of a water, but rather upon certain dissolved substances which exert a modifying influence upon the universal tendency of even the purest water to initiate the corrosion process. This inherent tendency of pure water to attack metal may be greatly aided in those cases where dissolved gases exist in the liquid; and under such conditions the term active typifies its corrosive qualities. An inactive water is one that is not able to promote in any marked degree the corrosion of iron.

The sharp boundary between the behavior of these two types of water furnishes a sufficient reason for thus distinctively classifying them. It is a simple matter to demonstrate the fact that an inactive water, after a few minutes' aeration, becomes capable of great damage to iron. If oxygen can be eliminated from water, with the effect of rendering the latter inactive, corrosion in pipes, tanks, boilers and in other similar places may be virtually prevented.

Practical Consideration

During the past year no new work was undertaken on the application of the deoxidation principle for the prevention of corrosion in pipe, due to war-time activities, which demanded all our time. However, the new test pipes put into the Irene Kaufmann Settlement installation at Pittsburgh two years ago, using deoxidized water, have been re-examined and the following report of the Pittsburgh Testing Laboratory describes the results to date:

"Originally included in this test were two 29-in. lengths each of 2-in. uncoated black steel pipe and 2-in. wrought iron uncoated black pipe. The installation was made Nov. 22, 1916, on which date it was first put into service.

On Dec. 24, 1917, the pipe line was reopened, and the wrought iron pipe and steel pipe found to be practically uncorroded after more than a year of service. Their inner surfaces were covered with a soft black slime. Oxygen removal by the deoxidizer had at times been incomplete, because of the low temperature of the water. Nevertheless, corrosion had caused during this time perforation of duplicate pipes in part of the same hot water system unprotected by the deoxidizer.

Samples of the zinc and brass which had been in the line for 42 days showed virtually no corrosion, while similar samples in the unprotected part of the hot water line showed pitting of the zinc and solution of the zinc constituent of the brass, leaving metallic copper at the edges of the brass samples. The zinc and brass specimens were put back into the line and riveted couples of steel and copper sheets, and of steel and brass sheets, were also placed in the line. Copper rivets were used.

On Jan. 3, 1919, after 2 yr. and 42 days of service, the condition of the pipes in the deactivated hot water line was again observed and found to be so good that it was decided to continue the test for at least another year. The pipes then showed the same soft black coating, but no evidence of pitting, even where the steel pipe was in contact with a brass union, a condition favorable to rapid corrosion by electrolytic action.

The specimens of zinc, brass, etc., already mentioned, were removed, and sent to the laboratory in order to determine their losses in weight and general condition. Relative losses of weight were very striking. In the deactivated water, in about 12 mo., the zinc plate had lost only 1 per cent, as compared with 10 per cent in the untreated water in the same line. During the same period the brass plates lost less than 0.1 per cent in the deactivated water, as compared with more than 1 per cent in the untreated portion of the water in the line. In the riveted brass and steel couple the steel lost about 16 per cent in the deactivated water, but was entirely corroded away in the untreated water in the same line.

In the case of the riveted steel and copper plates, the loss of weight of the steel in the deactivated water was 20 per cent, while in the untreated water the steel was destroyed by corrosion before the end of the 12 months' period.

Removal of the oxygen by the deoxidizer has been the means of hindering the corrosion of wrought iron and steel pipe exposed for over two years in a hot water line. In the meantime, specimens of the same iron and steel pipe have failed by pitting in less than a year in an unprotected part of the same hot water line.

Although the deoxidizing system mentioned above has now been in use continuously for over 3 yr. the apparatus has never been opened for renewal of the steel plates or filter material. After this period the analyses of the water shows the same percentage of oxygen removal as was found when these plants were installed.

An interesting piece of data was obtained at a recent inspection from test plates of zinc and some pieces of steel riveted to copper and brass plates. These were all weighed and inserted into hot water lines, average temperature about 160 deg. F., carrying about the same volume of raw and deactivated water for about 14 months. The weights of these pieces before and after this test indicated a greatly reduced loss of weight for the zinc and brass plates in deoxidized water.

In untreated water the average loss of three zinc plates, 2 by 6 by 0.25 in., was 1.174 grains per sq. in., while in deactivated water the average loss was only 0.153 grains per sq. in. In the case of the steel and brass plates riveted together, with an area of 14 sq. in., the brass lost 0.036 grains per sq. in. and the steel was a total loss in untreated water. In the deactivated water line the brass loss was only 0.008, and the steel loss 0.1815 grains per sq. in. Free oxygen in this water was reduced on the average to about 7 per cent of the amount found in the raw water, so that with a larger plant and more perfect deoxidation, still better results might be expected.

There has been considerable trouble with some brass pipe with ordinary hot water due to development of

*Extract of a discussion before the American Society of Heating and Ventilating Engineers.

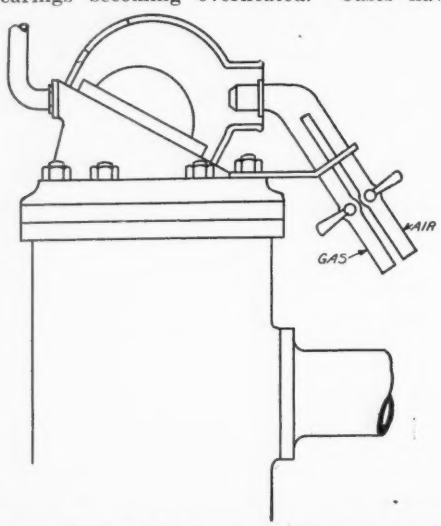
porosity and leaks which are first manifested by a white incrustation on the outside of the pipe. In galvanized pipe the zinc dissolves away rapidly, and in this way protects the iron, but the protection is only good for 2 or 3 yr. where the waters are moderately soft. So it appears that the brass pipe will be protected in practice almost as much as galvanized pipe by the removal of free oxygen.

It is of practical interest to note that in the 3-yr. trial which this system has undergone the oxygen removal has not been complete, yet there is no perceptible action of the deactivated water on unprotected iron, steel or brass pipe. A considerable amount of hydrogen has been found in this water between which and the free oxygen some proportionate ratio would seem to exist, which inhibits corrosion.

Oil-Engine Operation Notes

By "An Old Hand"

LUBRICATION of crankpin bearings of enclosed gas and oil engines presents some difficulties, and risk of trouble is increased by the fact that the bearings are not visible, so that usually there is no indication of the bearings becoming overheated. Cases have been known where engines have been kept in service for some time after the white metal in these bearings has melted out, and in a case recently investigated, in which the driver had reported loss of compression and unsatisfactory working of his oil engine, this was found actually to have occurred.



TORCH APPLICATION FOR QUICK STARTING OF OIL ENGINE

The engine was the usual hot-bulb two-stroke cycle type, and the melting of the anti-friction lining in the bearing allowed the gunmetal shell to bear on the pin, thus causing reduced compression pressure in the cylinder. Owing to the pressure being always downward, slackness of the bearing did not produce a knock, such as would be obtained with four-stroke cycle engines.

Various devices have been evolved to eliminate this weak point of enclosed engines and it has been found that a forced lubrication system is the best; just the same method of lubrication as has been found essential for enclosed steam engines. With oil engines working on the two-stroke cycle, and using the crank-case as a scavenging pump, this cannot be adopted owing to the risk of the lubricating oil being taken into the cylinder with the air. On these engines the crank-case must be kept free from oil that can be splashed by the connecting rod, that is, on all except the very small sizes, and the following experience illustrates the importance of this.

An engine of this type was installed for driving a line shaft, from which numerous small machines were driven and it gave very satisfactory results. One morning the driving belt came off the countershaft pulley, and the driver promptly cut the fuel pump out of action to stop the engine. It was seen that the engine continued to run at its normal speed, and with the compression release tap open, the engine still maintained its speed and appeared to fire regularly.

The engine was stopped by putting load on the flywheel with a long plank of wood, and it was then found that the crankcase had such an amount of lubricating oil that the connecting rod and crank splashed into it. The occurrence was explained by the oil being thrown up into the air port, and taken into the cylinder with the air. Care was afterwards taken to drain all the oil from the crankcase and not allow any accumulation. As this is very thick when cold, owing to mixing with the deposit that passes the piston, it is advisable to drain the oil off while the engine is running.

On these engines the most satisfactory method of lubricating the crankpin bearing is by a reliable force feed lubricator delivering oil under pressure into a grooved ring, fixed on the crank to lead the oil to the revolving pin. The lubricator should preferably work at a slow speed, as then the viscosity of the oil does not affect its regular and uniform supply, and it must have a sight feed. The oil should pass through the sight glass by gravity, and this is best done by using two plungers to each feed; one of which draws oil from the chamber and delivers it through the sight glass to the suction of the second plunger which forces it to the bearing.

Water or any other substance in the sight glass should be avoided, and the lubricator plungers should deliver oil only, not air and oil. It is better for non-return valves to be fitted at the end of any feed pipes more than about 3 ft. long, and one of these valves should always be used on the pipe leading to the crankpin.

In high-speed engines the weight of all moving parts needs more consideration than usual, as the speed of revolution causes the inertia forces to become appreciable and if the weights are greater than necessary an excessive amount of wear may be produced. A good illustration of this was found on an engine of modern design on which complaints of wear of the valve gear were received.

Investigation showed that the parts were much heavier than necessary, and a substantial reduction was made in the weight by using hollow tube instead of the heavy rods. The result was that the wear was greatly reduced. Inertia stresses have an important effect on the wear of all parts and in valve gears are more often responsible for new pins and bushes being required than any other cause. Even some Diesel engines have push rods made of light steel tubes in order to keep the inertia forces as low as possible.

Attention is now being given to the quick starting of oil engines and several forms of rapid starting lamps have been evolved. These usually employ paraffin and the fuel is atomized by a small supply of air compressed to a few pounds pressure, the vapor being ignited and the flame directed upon the vaporizer.

A somewhat unusual form of rapid starting lamp was seen recently on a hot bulb engine.

The lamp consisted of an ordinary blowpipe as used for brazing, supported by a clip attached to the cylinder head of the engine, as shown by the accompanying illustration so that the nozzle was a few inches from the bulb. The compressed air and gas pipes were connected to the branches of the blowpipe and the flow of air and gas regulated by the taps in these branches. After lighting the lamp the intensity of the flame can be adjusted and the amount of heat is dependent upon the air pressure.

With an air pressure of about 60 lb. per square inch the bulb can be heated sufficiently for starting the engine in about 3 min., but the lamps will work with quite low air pressures. Both town gas and producer gas under pressure can be used, and the former is the more satisfactory for heating the bulb quickly, especially if the air pressure is not high.—Gas and Oil Power.

First American-Built Battle Plane Now on Exhibit

THE U. S. National Museum now has on exhibition the first American-built battle plane constructed in this country for the U. S. government. This plane was constructed in Dayton, Ohio, by the Dayton-Wright Airplane Co. and was completed on Oct. 29, 1917. It is the first plane flown with a Liberty 12 motor. The De H. 4 was adopted by the United States government in 1917 for use by the American Expeditionary Forces as a day-bomber and observation plane. It was first flown on the day of its completion at the South Field of the Dayton-Wright Co. in Ohio. Since that time it has been used for all military tests and experiments intended to improve the De H. 4. In all, more than 2500 experiments, ranging from motor tests and different propellers to slight changes in control surfaces, have been made on this machine.

It has been used in more than 4000 flights, has been in the air for more than 1078 hr. and has traveled more than 111,000 mi. Twenty-eight of the trips made by this machine were for more than 100 mi. each, including trips from Dayton to Washington, New York, Philadelphia and return. As seen on exhibition in the museum, it is as originally constructed, save for a new coat of military paint. With the exception of a patch on the landing gear and a new section on the side cowling, there have been no repairs made to the ship.

The machine carries full military equipment, including 10 No. 25 bombs, camera, wireless telegraph and generator, oxygen bottles and helmets, intercommunicating telephone, heated clothing and generator and armament consisting of two Lewis and two Marlin machine guns.

About 1800 of these planes were delivered to the army in France, and they were used extensively on the front for day bombing and observation work.

This ship was criticized severely during the period of the war on account, chiefly, of a failure on the part of the public to understand its purpose. It was designed to serve either as a fighter or a bomber. When sent up for combat work, it carried a light load and was able to attain greater speed at 17,000 ft. than any other ship used in the war. Its maneuvering ability when carrying a light load was considered good. When sent up on a bombing expedition it necessarily carried a much heavier load and its speed and aerobatic ability suffered as a result.

The maximum speed of the De H. 4 is set at 122 mi. an hour, but a much higher speed has been developed. Its landing speed is 58 mi. an hour. Its wing span is 42 ft. 5½ in.; length over all, 31 ft. 1½ in.; height, 11 ft. 9 in.; gap, 5 ft. 10 in.; total supporting area, 440 sq. ft. Its weight with a full load and military armament is 3800 lb.

Let's Pay Our Debt

THE WAR was fought on credit. Every man sent, every gun, every grenade, ship, shell—every load of rations, every motor—all was sent on faith in the credit of the United States.

Credit is a safe and legal way of discounting the future. But to keep it safe, the important element is paying at maturity.

The government has borrowed the money to fight the war on credit. The notes must be paid. It is for us—the people whom the government represents—to do the paying now. There is only one way. Subscribe for the Victory Liberty Loan.

Six months will be allowed to pay for the bonds. Ten per cent with the subscription; 10 per cent July 16; 20 per cent Aug. 12; 20 per cent Sept. 9; 20 per cent Oct. 7; 20 per cent Nov. 11.

Prosperity of the country, good wages and chances for jobs depend on the success of the Victory Liberty Loan. It is to pay our debts as a nation. Consider what you can save and invest in six months. Then Buy All You Can Pay for.

The United States Shipping Board states that since the establishment of its squadron of Merchant Marine Training ships in January, 1918, to April 1 of this year, 22,523 American citizens were accepted for training on the ships as apprentice sailors, foremen and stewards, a majority being under 25 yr. of age. The course of training is 2 mo. and graduates are shipped in crews of both coastwise and ocean-going vessels under the American flag. The board states that it now wants 2000 more young men for training as apprentices. The board also announced that its free schools for Merchant Marine officers, established in June, 1917, to give experienced seamen and engineers special training to fit them for license examinations, had graduated up to April 1, 1919, 8109 men, all Americans. In this total deck officers and engineers were almost equally represented.

If France is poor in coal, such is not the case in water power, and it is principally through the utilization of this factor that the industrial future of the nation looks hopeful.

Explosion of a Blowoff Tank

INVESTIGATION of a blowoff tank explosion which occurred in a manufacturing plant at Cleveland, Ohio, fortunately with no personal injuries to life and but slight property damage, has been made by engineers of the Travelers Insurance Co., and from their report the following information has been taken:

This particular tank was composed of cast iron and was 36 in. in diameter and 48 in. in height. Its cover was also of cast iron, and was held in place by 16 ½-in. bolts. The tank was set vertically in the ground, and was buried to within about 12 in. of the top, in a pit at the back of two horizontal tubular boilers which discharged into it.

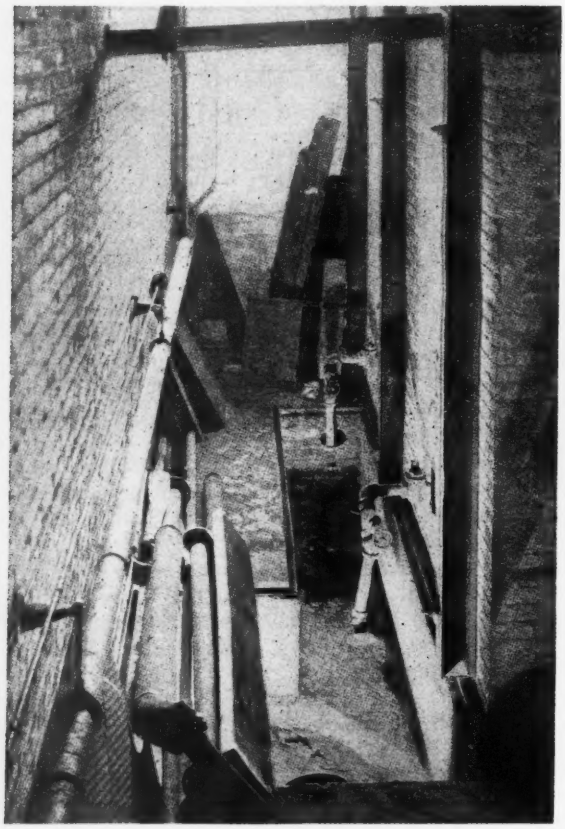


FIG. 1. LOCATION OF THE BLOWOFF TANK

There were two openings on opposite sides of the tank, near the top, both of which were tapped for 4-in. pipe and bushed for 3-in. connections; these were for the inlet and discharge pipes, respectively. A Cleveland city ordinance prohibits the blowing of steam under pressure into brick sewers, and in order to comply with this ordinance a 2-in. vent pipe was tapped into the cover of the tank, and was extended up over the top of the boilers and into the smokestack. The discharge opening from the tank was hooded over—the hood extending nearly to the bottom of the tank from the boilers escaped through the vent pipe, and the water was siphoned out through the discharge pipe. The vent pipe was also intended to relieve any pressure that might be caused by blowing down the boilers when the tank was full of water.

The story of the accident, so far as we know it, is as follows: The engineer, hearing the whistle blowing for high water on one of the boilers, immediately shut off the feed, went to the rear of the boilers and opened the blowoff valve about one-third of a turn. He then returned to the front of the boilers to observe the action of the water in the gage glass. At about this time hot water and steam began to spurt into the air through the perforated iron cover of a sewer drain in the boiler-room floor. As soon as the engineer noticed this he went to the rear of the boilers again, with the intention of closing the blowoff valve. To reach the valve it was necessary to step over the pit in which the tank was situated; but when he was still about 3 ft. from the pit the cover of the tank burst and was thrown into the air, breaking off a 3-in. steam pipe at a height of about 12 ft. above the boiler-room floor. This made it impossible to reach the blowoff valve and close it, so the engineer ran back and pulled the fire from under the boiler.

The day on which the explosion occurred was quite mild, and snow in the streets was melting rapidly. The sewer is but 15 in. in diameter, on the street where the plant is situated, and is inadequate to take care of a heavy runoff of surface water, such as that which was in progress at the time. The boilers are installed in the basement of the building, and the blowoff tank was sunk in the ground, as already described. Because of this arrangement the difference in the levels of the sewer and the blowoff tank was not great, and as a result the water backed up from the sewer and completely filled the blowoff tank and the inlet pipe from the boilers, and also sealed the vent pipe. In view of all these conditions, it seems quite likely that the explosion was caused by water-hammer action due to opening the blowoff valve, and the resulting agitation of the cold water in the tank produced by forcible mingling with it of the steam and hot water from the boiler.

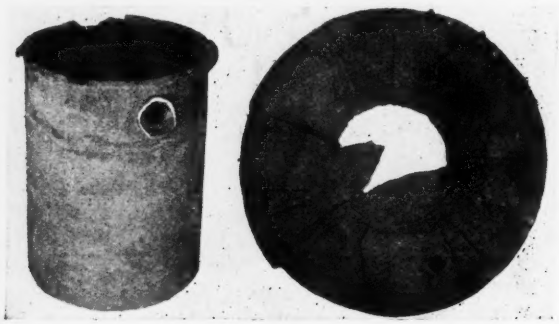


FIG. 2. THE TANK AFTER THE ACCIDENT

FIG. 3. THE COVER OF THE TANK, SHOWING RADIAL FRACTURES ASSEMBLED FOR PHOTOGRAPH

LINCOLN said: "When an occasion is piled high with difficulty, we must rise to the occasion." There are war tasks to be concluded, readjustments to be effected, individual and national prosperity to be achieved.

WE WON the Victory, now let's put over the Victory Liberty Loan!

Rehabilitation of Men

WHAT ENGINEERS CAN LEARN FROM THE NEW POLICY DEALING WITH THE DISABLED SOLDIER. BY DOUGLAS C. MCMURTRIE*

IN THE past, our method of dealing with men permanently disabled in the course of employment has been to pay the worker a pension in the form of compensation, and forget him and his injury. But the cost of disability to the engineering industry has not been alone in the premiums paid for casualty insurance. There has been the cost involved in the training experience, and adaptation of a skilled worker who does not return to his job, and fitting of a newcomer to take his place.

There are three means of reducing and approaching the complete elimination of the cost of disability: first, accident prevention; second, thorough medical attention to minimize the disability resulting from the injury, and, third, salvage of the remaining abilities of the worker through rehabilitation for self-support. The first of these has already received wide attention from employers and has wisely been encouraged in a financial way by casualty insurance companies and state funds. The values of the two latter have, however, not as yet been appreciated. Their energetic application would effect a tremendous saving to industry.

Many injuries from which men would completely recover in a short time under adequate and high-grade medical attention are treated for an insufficient time, or by incompetent physicians; and, instead of a prompt return to work, the case at best drags along over an extended period and at worst becomes chronic or develops into permanent disability. Some states require the insurance carrier to provide but two weeks of compulsory free medical attention to the injured man. For the insurance company to take advantage if this limitation is the most short-sighted policy possible, because for every dollar saved in physicians' or hospital fees the insurance carrier pays out later ten dollars in compensation.

Unlimited medical attention of the highest grade should be an axiom of casualty practice. It should be insisted upon by employer and workman alike. The best outcome of any injury is to have the employe return to his job as a well man in the shortest possible time. It is well to develop a science of dealing with cripples, but the ideal is to have fewer and fewer cripples with which to deal.

The third method of attack on the cost of disability is rehabilitation for self-support—the re-education of an injured man for an occupation which he can follow, or a process which he can perform, in spite of his handicap. The science of rehabilitation is new, and the experience in it has practically all been gained in the effort to make sound and just provision for the disabled soldier or sailor. Every country among the recent belligerents is today operating a comprehensive system of re-education for disabled soldiers, and is placing upon that system more dependence than upon the pension system.

With the breakdown of confidence in the pension system, it was realized that the only real compensation for disablement was restoration of capacity for self-support. It was further realized that very few jobs require all the physical faculties and that in the present-day variety of industrial processes it is possible to find a job in which a man with a given type of disability can work 100 per cent efficient. Some jobs are standing, some seated, others require walking about, some jobs at a bench working on small articles require but little strength, others involve great physical exertion. Still others do not require the sense of hearing, in others the sense of sight is not essential. Finding the future work of the disabled man, therefore, requires expert and painstaking choice, but a successful selection is possible even from the seriously handicapped. The first aim is to place the man back in a different job in his own trade or in a trade closely related. In such a job his past experience will stand him in good stead. Failing this, he can be retrained for a different line.

The process of retraining the disabled is known as re-education, and can best be provided in a special school for crippled men. The first school of this kind in the United States is the Red Cross Institute for Crippled and Disabled Men, established in New York City through the generosity of Jeremiah Milbank. At this school, open to disabled civilians and soldiers alike, six trades are already being taught, artificial limb making, motion picture operating, oxy-acetylene welding, printing, jewelry work and mechanical drafting. More will be added as the demand develops. Graduates are already giving satisfaction in the jobs to which they have been graduated, so the enterprise has passed the experimental stage. And in the results attained with disabled soldiers abroad there is overwhelming evidence of the logic and practicality of rehabilitation.

The cost of soldier rehabilitation is being met by the United States government and by the governments of some of our allies. It will be admitted without argument as desirable that the advantages of re-education be made available to disabled civilians as well, but will not the cost be prohibitive? The fact is that rehabilitation effects a reduction rather than an increase in the cost of disability to industry or to the community as a whole.

A typical case will illustrate how the saving is effected. A worker in Massachusetts was injured by a fall while working inside a submarine and his hand became permanently crippled. In due course his compensation rate was determined and he was referred to the insurance carrier to be paid $10 a week for a long period, with a maximum total payment of $4000. Since the disability was manifestly permanent, the insurance company wrote the case off their books as a $4000 loss and transferred that amount to reserve to cover the weekly payments. After the compensation had been paid for nearly a year a new official of the insurance company began looking over the list of men to whom the company was paying compensation. His attention was directed to the man in question, and the latter was re-

* Director Red Cross Institute for Crippled and Disabled Men, Twenty-third Street and Fourth Avenue, New York City.

quested to call at the office of the company. The case was like many thousands of others susceptible of rehabilitation for self-support, so the insurance company official put a proposition to the man in very frank terms. "I believe that you can be trained to earn a good living. I want you to understand very clearly, however, that this proposal is to the financial advantage of the company, but I also believe it is to your advantage as well. A total income of $10 a week is not very attractive to you and you would probably rather return to work at a good wage than remain idle. If you will consent, the company will send you to a school of re-education and see if we cannot get you back on your feet in good shape."

The injured man consented to the proposal, and the company sent him to the Red Cross Institute in New York. They began to pay him not $10 a week as required by law, but $40 a week, $20 to him in New York and $20 to his wife at home. The company also paid liberally his traveling expenses in both directions. In the period of eight weeks he was re-educated in oxy-acetylene cutting and welding and returned home. He is now making not only a satisfactory wage, but twice as much as he had ever earned before the accident took place.

In the whole transaction every party at interest was benefited. The man was advantaged in that his general living standard was distinctly raised, and the necessity of working for his living could not be considered as a hardship. The company paid less than $500 for his rehabilitation, and this expense, in conjunction with the $500 already paid in weekly compensation during the first year of idleness, made a total for the case of $1000. They were thus enabled to charge $3000 of profit to the account of profit and loss. The community was infinitely the gainer in that the man, formerly an unproductive consumer, became a useful producer instead. The community further gained in the elimination of the disabled man from the category of a prospective dependent, because while compensation might have taken care of him in a very insufficient way during the period of idleness there would have come a time when compensation ceased, and then he would have been in a desperate economic status indeed—confirmed in habits of idleness, untrained for skilled work and without any source of support.

A more intelligent handling of disability by insurance carriers will, therefore, reduce their expense, and will thus cut the cost of casualty protection to the employer. There is needed also, however, some revision of compensation laws so that there may be definite encouragement to insurance carriers to offer opportunity of rehabilitation and definite encouragement to the disabled men to take advantage of it. Practically every compensation case that has ever come to the Red Cross Institute has come on the day his compensation expired. For one year, for two years or for four years the man existed in idleness, drawing compensation and cultivating habits of indolence. When his support was cut off he then became interested in rehabilitation. Present compensation legislation tends to encourage the man to remain idle because his payments are reduced by any improvement in earning capacity. A revision of this practice will make for more constructive provision.

In short, the first effort should be to prevent injury, the second to minimize its permanent effects, the third —when disability has ensued—to offset its economic consequences. The execution of this complete program is not only humanitarian practice—it is good business.

Bonuses for Fire-Room Efficiency

IF A fireman is to become an expert in coal economy, it must be worth his while to learn, and worth while for someone higher up to teach him. Rewards for coal-saving are paid by the Charles Pfizer Co., of Brooklyn, according to an ingenious scheme applied by F. S. Jones, works engineer. For the watch engineers, a bonus of 10 per cent of their pay is given, conditioned on the maintenance of an evaporation rate of 8.4 lb. of water from and at 212 deg. F. per pound of coal. This requires that their responsibility for the cleanliness of boiler surfaces, inside and out, shall be taken quite seriously, and that each man should see that the fireman on his watch should maintain his fires in proper condition. The fireman's bonus in turn depends on their maintaining an average CO_2 per cent of 11.6, as shown by analysis of gas drawn continuously during each watch. Coal passers, too, receive a bonus if they keep the firing floor in good order and lose no time. In all cases, a man who cannot or will not earn his bonus regularly is not retained.

The Pfizer plant manufactures chemicals, and hence uses electric power and steam at high and at low pressures. Its boiler plant consists of two 380-hp. boilers, equipped with underfeed stokers and forced draft blower and eight 150-hp. hand-fired boilers, of which but two are kept on the line as a stand-by when cleaning fires. The new stoker-equipped boilers are served by a coal-conveyor, which later will be extended to serve two additional boilers to be installed in the open space at the right. Ashes are removed by a dump-bucket run under the boilers on a car whenever the stoker ash-dumps are opened. It is lifted and dumped into a motor truck by an electric hoist.

Feed water is taken from deep wells on the premises. Steam at 80 lb. is used for cooking, and for power in high-speed reciprocating engines. Exhaust steam at 4 lb. is used for heating and drying. Bituminous run-of-mine coal is burned.

THE U. S. SHIPPING BOARD wants to hear from every mariner in the country qualified to fill a first mate's job on salt water. It also wants the address of first assistant engineers. There is a present shortage in both grades in the Merchant Marine, and highly paid positions are ready for men who can fill these places properly. Qualified applicants for positions are directed to report to the Sea Service Bureau at any large American port. Owing to the great demand for officers in the grades mentioned, the Shipping Board has ordered its officers' training schools to accept for intensive training any merchant marine officer who wishes to brush up in preparation for examinations for a raise in grade, and second mates and second assistants are urged to take these courses, in order to shorten the time in which they may obtain first mates' or first assistant engineers' licenses.

A Mechanical Thermometer

A THERMOMETER on some of the hot water lines of a plant is very desirable and often a necessity, but it is sometimes hard to make the boss see it in the same light as you do and so you have to do the best you can. Such a condition existed in my plant and led to the making of the thermometer described in this article.

Water for house service is heated by live steam, controlled by a thermostatic valve. The thermostat and the thermometer are near each other in the tank, so that they practically work together. When I first took charge nearly every morning the office would call up, saying that the guests complained of the water not being hot enough. I would consult the thermometer and usually it showed about 150 deg. F., which was where the thermostat was set to shut off. After a while, I installed a bypass around the thermostat and when I received a complaint I would open it, but I had no means of telling when this was necessary until somebody kicked.

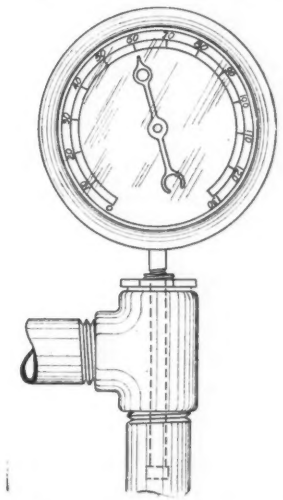
I told the manager that there must be considerable difference in the temperature of the water leaving the tank and that shown by the thermometer, but he did not think so. He said that the thermometer must be out of order, so we had it tested and it proved to be correct to about one degree.

Make-up for boiler feed is taken off the hot water line, just outside the heater and I asked the manager to get me a thermometer to put on this line where I could see it; but he was having an economical spell just then and would not buy it, so I made one. When I installed it in the line, it showed that when there was a heavy demand for hot water, the water leaving the heater would be from 20 to 30 deg. F. lower than the heater thermometer showed.

I came to the conclusion that this was due to the fact that when a large volume of water was being used, it set up a direct flow of water from the cold water intake to the outlet. The thermometer and the thermostat are at the opposite end of the heater from the inlet and some distance below the outlet, near the steam coil, so that under these conditions there is apt to be an eddy formed at this point and consequently very little reduction of temperature there. The thermostat being nearly shut off, I get water of a much lower temperature in the house lines than the thermometer indicates. It is impossible to change these conditions, but with a thermometer on my feed line where I can see it, I can open the bypass, thus doing away with the kicks.

The thermometer is made from an old steam gage and a few pipe fittings. The first step is to fill the gage tube with some light oil. I used Valvoline White Dynamo oil. In order to get the tube full, the air must be expelled. Turn the gage so that end of the tube is up and with a medicine dropper put in as much oil as possible. When it is apparently full, rotate the gage slowly, so as to allow the air trapped in the tube to work upward around the curve. Keep this up until no more bubbles show and you can get no more oil in the tube. Then take a piece of ¼-in. pipe and screw it into the bottom of a ⅜-in. flush bushing. Take a ¼-in. pipe cap, cut a thick leather washer to fit snugly in the bottom of it and make up tight on the other end of the pipe. Put white lead on all joints, as they must be absolutely tight.

Now fill the capped pipe full of oil and screw the gage tightly into the opposite end of the bushing. Remove the hand and dial from the gage. Reverse the dial and put back in place with a temporary dial of



A MECHANICAL THERMOMETER AND ITS MEANS OF APPLICATION

white paper over it. Place a bucket where you can run hot and cold water into it and place the stem of your thermometer in it alongside a mercury thermometer. Place the hand in the position of zero pressure and fill the bucket with cold water. Then slowly increase the temperature of the water, marking the rise on the temporary dial as shown by the mercury. When you reach the maximum temperature, reverse the process and check your calibrations. If you wish to be exact, repeat the process several times. If the hand does not have sufficient travel, there is still some air in the tube which must be removed. From this temporary dial you can now lay out a good one and place it permanently on the gage.

In order to put it in the line, it is now only necessary

to bush down one end of a tee in the line to ⅜ in. and screw the gage in tight. If all pipe joints are tight and there is no lost motion in the working parts of the gage, it will register quite accurately and is somewhat more sensitive than a mercury thermometer.

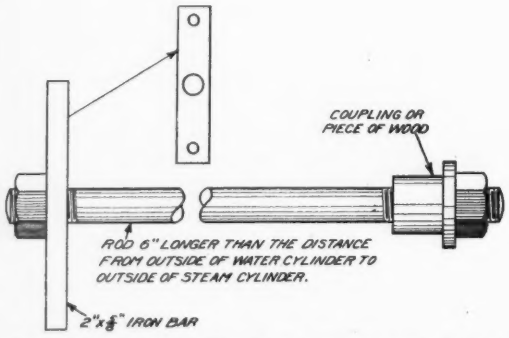
J. W. Eshnaur.

Putting in New Pump Sleeves

It may be of interest to those not familiar with this kind of work to learn how we do it and with good success.

Turn down an iron rod to fit snugly in the stuffing boxes, long enough to extend 3 in. outside of the steam and water cylinders. Get a piece of iron 2 by ⅝ in. that will reach across the steam cylinder head, make three holes in it, the two outside ones to fit the studs on the head and the one in the middle to fit the rod to be used for putting in the sleeve.

Get pipe coupling with a plug screwed in on one end, turn this down to fit the sleeve inside, with a shoulder on the plugged end equal in diameter to the diameter (outside) of the sleeve; drill a hole in the plug to fit the rod.


COUPLING OR PIECE OF WOOD
ROD 6" LONGER THAN THE DISTANCE FROM OUTSIDE OF WATER CYLINDER TO OUTSIDE OF STEAM CYLINDER.
2"x⅝" IRON BAR

DEVICE USED FOR PUTTING IN PUMP CYLINDER SLEEVES

Make a long thread on the end of the rod to be used on the steam end; the length of thread depends on the length of water cylinder; also make thread on other end of the rod to receive a nut.

Now we are ready to take out the pistons and rod. First make a mark where the crosshead is made fast on the piston rod, loosen up the glands and take out the packing, mark the cylinder covers so as to get them back right, put nuts on two different strings, and it is always advisable to put each one of the nuts back on the stud where it was taken off.

Take plunger out, loosen up on the crosshead and push the rod and steam piston out, take old sleeve out, cut a groove the whole length of the sleeve, using a round nose or cape chisel; be sure not to cut through; start on the outside end of sleeve and bevel the metal up on one side of the groove until sleeve can be taken out.

Clean out, but do not scrape or file the water cylinder; make the plugged coupling fast to the short threaded end of the rod and put sleeve on the coupling; be sure to have sleeve square; put rod in through the stuffing boxes and the iron piece and fasten the nut. Have somebody tap the nut on the other end lightly as you put strain on the nut.

Do not put too much strain on the sleeve, as it is easily destroyed; rather take it out and file it a little.

If it is too small, prick-punch the cylinder so as to make the surface rough. The coupling is used to prevent the sleeve from bulging in while under strain.

If a coupling is not on hand, a piece of wood with an iron plate on one end will do just as well.

Charles Magnus.

Kerosene and Graphite for Boilers

Having read with considerable interest letters pertaining to the use of kerosene oil in boilers, I wish to add my bit to what these writers have written, hoping it may be of some benefit to others.

During 25 yr. active experience in operating, erection and installation work in practically every branch of the engineering service in nearly every state in the Union, and naturally coming in contact with about every different kind of boiler feed water—good, bad and indifferent—and noting what troubles the bad waters caused, the writer has profited greatly by such past experience and gladly passes some of it on to readers.

Erecting engineers are looked up to by operating men and are asked for much advice on problems that are vital and are bothering operators, who are clamoring for a quick solution. Operators know that the erecting men run up against all kinds of service problems, and, due to their resourcefulness, come out victorious in nearly every problem or job they tackle. Operators may not realize that the erecting man must solve the problems, must use his brains to the limit or lose prestige. He dare not ever acknowledge defeat. It would ruin him. Sent to do any piece of work, he must do it successfully, or make room for a man who can do it.

Now, as to kerosene oil, it is about the cheapest and, all things considered, the most widely used boiler compound substitute the writer has ever seen. It is used for every kind of water and with considerable success. I've seen it used successfully in boilers that are used for irrigation work, and as the season is about 125 days' continuous operating, and no reserve units are available, the plant in its entirety must run through the season, with all kinds of water, nearly all surface water, sometimes from rivers such as the Rio Grande and Colorado, Trinity, Red River, etc., which carry in suspension great quantities of silt, very fine and hard to settle out, even if given considerable time, and as there is very little incentive to install settling basins, filters, etc., when only 125 to 130 days' run constitutes the year's operation, you can readily see that the operating engineer must simply do the best he can with the existing plant, and it's a case of keep going. Kerosene oil fed continuously through the average compound feeder or one made of pipe fittings and valves on the job, and the sight feed, taken usually from an old sight feed lubricator, constitute the average feeder in such plants, and the rate of feed about 3 to 5 drops per minute. The use of blowoff 3 to 6 times daily, and dropping one gage each time, keeps boiler reasonably clean, and the plant runs, which is the main requirement.

Plants that do not use kerosene or a regular boiler compound gradually get in a bad way and cannot make

the continuous run, but must shut down to clean boiler —using as many men as can possibly be crowded around and into the boiler, and as the brickwork cannot be cooled down properly, it is usual just to pull fires quickly, and while there is yet steam in the boiler to operate the pressure pump the hose is used to sprinkle the brickwork to remove as much heat as possible, use steam as long as engine will turn over and then open blowoff wide and let everything out. This is hard on boilers, brickwork and cleaners, for the boiler cannot be cleaned as well as it should be, and it must be put back in service again at the earliest possible moment. Using kerosene avoids all that.

Of course I would advise everybody to consult a competent chemist, or get in touch with reliable water treatment people, as much better and more uniform results accrue from using the right thing in the right place at the right time, which is not always the case when kerosene is used; but, as I said before, owners of such plants simply will not purchase good boiler feed water treatment, and it is up to the operator to do what he can with what he can get.

I learned an old saying by heart when a boy. It is, "When you can't get what you want, want what you can get." The truest way to be happy is to follow it.

In other plants where the finished product, or product in process of forming, is in danger of absorbing the odor from steam, no kerosene oil whatever should be used, for grief awaits those who use it even if but a thimbleful is used. It is fatal, the steam will carry that odor everywhere, even graphite grease used in manhole plate gaskets will sometimes cause a loss of product; the engineer must be exceedingly careful. In case a water treatment is required, consult a good chemist; you are safer.

In office buildings where regular gravity system of steam heating is used, no kerosene should be used, as the air valves on radiators give off an obnoxious odor and tenants frequently send in kicks to management, and kicks do not tend to make the engineer's lot pleasant. The practice of pouring a gallon or two of kerosene oil into an empty boiler before starting the filling process and allowing the oil to spread all over the interior surface as it floats on the water as it rises is one to be recommended, as the oil rapidly reaches the metal and seems to loosen old scale and prevent new scale from forming. The kerosene treatment is beneficial in all or nearly all such cases. The judicious use of blowoff three or four times daily, dropping one gage at each time, is all right; the amount of sludge blown out of the boiler is enormous.

But I've pinned my faith on boiler graphite of late years. Graphite seems to attach itself to the metal and prevents scale formation and seems to intermix itself with the sludge and prevents its hardening, and it readily passes out upon opening the blowoff. The easiest way to introduce the graphite where no feed water filter is used is to stir a few pounds of graphite into a pail of hot water using any opening in suction piping of pump—preferably a valved line—and, while vigorously stirring the mixture, it passes through and is beneficial to pump plungers, valves, etc., and check valve faces and seats. There is, however, a disadvantage in using graphite in some plants—laundries, for instance. A small quantity of graphite around a laundry is fatal; scale is the lesser evil. Kerosene, though, is beneficial in cleaning operations. One very important rule to adhere to closely is to ventilate the boiler properly before putting an open light near open manhole or handhole opening. Failure to ventilate may mean a serious explosion that might injure the attendant or force the boiler to move bodily from its setting endwise; loosening the brickwork even slightly is serious enough. This has happened in two cases to my knowledge. The outpouring of flame from the manhole is vicious with even a small amount of gas. Ventilation is the remedy.

Kerosene also causes a high consumption of lubricating oil in all steam-using apparatus requiring oil. I, of course, with all conscientious engineers, realize the shortcomings of such makeshifts as kerosene, and much prefer having the water analyzed by a competent chemist and complying with his recommendation or treatment. In my experience with various water treatments of reasonably large capacities I have found that the hot process treatment is much more effective and more economical than the cold treatment, requiring less storage capacity. But in many cases operators must do the best they can with the equipment on hand. Some companies will not purchase new equipment for water treatment nor will they pay the small fee for chemist services. So kerosene and graphite, used judiciously, will enable engineers to pull through some mighty tight places in a season's run.

I have used the kerosene and graphite treatment combined in the water circulation system of gas engines, oil engines and air compressers where the water is recooled by tower for recirculation. It prevents scale formation, as it keeps the precitation in sludge form, which settles out in the corners of the storage tank. The intercoolers do effective work and tubes do not corrode to any extent.

The kind of graphite suitable for such work is of the amorphous variety, ground to a very fine impalpable powder or it will not remain in suspension.

D. L. FAGNAN

Acid Water From Coal Pile

THE ARTICLE appearing in the Feb. 15 issue of Power Plant Engineering, under the above caption, brings to mind a similar happening in a large eastern textile plant.

Adjacent to the fair-sized pond or enlargement of the river from which this mill took the water for boilers, dyeing and bleaching, was the coal-storage pocket with a capacity of 15,000 tons. The pocket was elevated on piles, and tracks extended beneath so that the delivery cars were filled through chutes in the floor. The side of the pocket was perhaps 20 ft. from the bank of the pond and parallel to it. The land back of the pocket was considerably higher than the ground within the mill yard, consequently that portion under the pocket was always more or less wet, and in severe weather, particularly winter, was frequently flooded. Drains were laid to conduct this surface water into the pond.

Two years ago the pocket was filled with coal, much of it being of poor quality carrying a high percentage of sulphur in the form of pyrite. As a result, fires in the coal were frequent, and at times much water was

used in putting out these fires or in simply cooling the coal. This water seeped through the coal, and, as we afterwards found, carried with it the iron sulphate in a ferrous state, which was an oxidation product of the pyrites or ferrous sulphide. As the ground was frozen at the time of the wetting of the coal, the water quickly reached the pond. Soon a reddish brown deposit was noticed on the banks, and a similar coating on everything that was immersed in the water. Upon testing, we found this deposit to be the ferric form of iron oxide, and the water was distinctly acid in reaction. The drainings into the pond were strongly acid, while on the ground was a heavy brown deposit similar to that in the water. What had evidently taken place was this: the ferrous sulphide or pyrites in the coal had been oxidized by the oxygen in the air into ferrous sulphate, which is soluble, and was carried off by the water draining through the coal. On exposure to the air and upon dilution, the sulphate was further oxidized and broken up, depositing the red ferric hydroxide and freeing sulphuric acid. The condition existing was discovered before any harm was done either in the boiler room or in the dye house. Soda ash was plentifully spread about in the main drains, on the ground under the coal pocket and along the banks of the pond. This not only precipitated the iron as the hydroxide, but united with the sulphuric acid, forming sodium sulphate, a neutral salt.

C. A. J.

Methods of Temporary Work

WHILE temporary work is done to carry over an emergency, it is many times obvious that such work

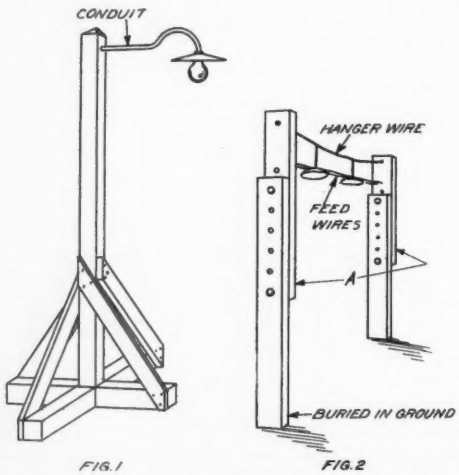


FIG. 1. MOVABLE STANDARD FOR TEMPORARY LIGHT
FIG. 2. BRACKET ARRANGED FOR STRING OF LAMPS

must stand up under the worst conditions. Such being the case, we laid out several schemes for temporary work which I will try to explain.

According to the underwriters' rules, 660 watts per circuit is the maximum allowable, so that with 250 or 500-watt lamps we could not get many lamps on a circuit, and also to limit outages, we did as follows: Taking a cutout of the style of a Trumble No. 2965, we bridged one set of the terminals with wire and in one placed a fuse and in the other fuse receptacle we screwed the lamp. This made the unit self-contained, and was readily attached to a board which could be put up in almost any place.

For lamps which must be moved around to different spots, we made up some standards, as shown in Fig. 1. In the base we placed weights of any description which prevented it from overturning. Also by bending the conduit we could spot the light in any place where it was needed the most.

For places where we could string groups of lights we made the bracket shown in Fig. 2. We made that piece marked A quite long, so that we could get plenty of clearance should the occasion demand it. By tying the wire to the cross pieces we could get any height of the lamps by tightening or loosening up on the wires.

DEAN B. COBB.

Oil and the New Chief

WHEN the chief took charge of the plant, the oil situation was one of the first he tackled. Formerly, oil was handled somewhat after this manner. The chief ordered a barrel of oil and after it reached the mill, some one rolled it onto a pair of horses, bored a hole in one of the heads of the barrel and drove in a tapered wooden plug. Then an oiler came along, pulled the plug and filled his oil can. Nearly as much oil dropped to the floor as went into the can. Then the oiler lubricated the many bearings on the lineshafts, pumps and machines and the oil, after passing through the bearings, dropped to the floor. Once a week, or oftener if occasion or a factory inspector demanded, the floor was washed with a hot water hose and through the drains the oil found a watery grave in the river. When the contents of this barrel of oil were exhausted, another was put in its place and the same wasteful process gone through week after week.

The owner of the mill, more interested in production than in oil, nevertheless knit his brows more than once over his oil bills, but that was as far as it went. No effort was made to save oil even through its sparing use. No one knew who used the most oil or where it was used. No one cared as long as the oil was constantly on tap. Oil was to prevent "hot boxes"; if a little was good, more was better.

The engines, although fitted with pipe connections to carry off all used oil, had never been piped up. Not even a pan had been placed under any part of the engines. Unsightly wads of waste and rags were strewn all over the floor—anywhere, in fact, where they would catch the oil. The machines on the upper floor were in no better shape. Such were conditions. It is hardly believable in view of these days of up-to-date oil saving methods, but such was the case.

The saving accomplished, even by reclaiming a goodly portion of the oil used in this small plant, would never pay for a high-priced filtering system such as were advertised in many trade and other journals, so it was up to the chief to devise a system of his own. He therefore put the oil question to the owner and this is what happened:

A local tinsmith was called in and in less than three weeks the new system was working. The two horses supporting the former barrel of oil had given way to

a small galvanized iron tank placed in the engine room and capable of holding a barrel of oil. An incline had been built to the top of the tank up which a barrel could be rolled, blocked and emptied without losing a drop of oil. The tank was fitted with an old spigot and under this was placed a pan. Any oil dripping into this pan could be returned to the tank. On a post, near the tank, was placed a daily record sheet showing how much oil was drawn, where it was used and who used it. In this manner the chief was able to check up the wasteful users. The engineer kept this daily record sheet and nobody except himself was allowed to draw oil.

Under every bearing, either hung or placed on the floor, appeared a small but efficient pan. Twice a week these pans were emptied into pails and taken to an old steel barrel, also located in the engine room, under which a small, exhaust heated steam coil had been placed. Here, water and oil were separated and most of the foreign matter precipitated to the bottom of the barrel. At slight expense, pipe was bought and the used oil from both engines piped to one centrally located large pan. Once every day this oil was emptied into the old steel barrel. At the bottom of this barrel, an old 1-in. valve had been placed to draw off water and dirt and at a point near the top, another valve served as a means of drawing off oil.

Each week, the separated but by no means clean oil, was drawn off and put through its final cleansing. The tinsmith had also fashioned, from the chief's sketches, another tank into which this oil was poured where, to reach light again, it had to pass through a liberal thickness of clean waste and through another clean warm water bath, after which it was returned to the first tank for re-use.

Occasional cleaning of all tanks was necessarily vital; but the installation, costing but little, was instrumental in opening the mill owner's eyes to the fact that he had been throwing away money. It also gave him confidence in the chief's ability, which was just what the chief desired. From this start, the chief suggested many other changes and improvements, all of which worked out to his and the owner's satisfaction.

Without a doubt, this mill was but one in a hundred operating under such wasteful conditions; but, as there is always room for improvement in any mill, no matter what its size, look about you, engineers, and see what you can do to save oil. Your employer will appreciate it when he sees the reduction in his oil bills and you will experience that satisfying feeling of a job well done.

J. W. S.

Care of Cup Leathers

AN ARTICLE in the Feb. 15 issue of Power Plant Engineering on the care of cup leathers recalls the trouble which a large textile plant was having a year ago with cup leather packings. The particular packings were 12 and 15 in. inside diameter, and were used on the rams of hydraulic presses operating under several tons pressure. These packings, as can well be imagined, were, at the prevailing price of leather, expensive; and as they were failing after two weeks' or often less service, the upkeep was costly. Some of the packings were made at the plant, while others were bought from regular packing-leather manufacturers. But the trouble still continued; the leathers would wear down on the inside until they were as thin as paper, all in a week's time. The plungers of the presses were being lubricated with an ordinary grade of yellow shafting grease such as was used on the plungers of the freight elevators operating under 90 lb. pressure. Most of the grease, however, was to be found on the head and gland and was of little use as far as lubrication was concerned.

As a last resort, the question was submitted to the press manufacturers, who sent a representative to investigate. The first inquiry he made was, "With what do you lubricate your packings?"

On learning that shafting grease was used, he shook his head doubtfully and said, "Let me see the plungers."

On examining these, he called attention to the fact that although the metal was not scored, yet the surface was quite dry and in many places gummy.

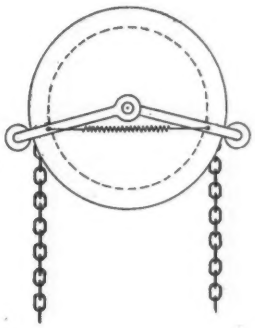
"There's your trouble. Your plungers are so dry and sticky that, as they pass through the packings, they wear them down in a very short time. Clean all the grease off from the head, gland and ram with naphtha. Then each time the press is operated, wipe the ram over with a cloth saturated with castor or olive oil, the former preferred. This will keep the metal clean and the leather soft and pliable.

This was done, and all trouble ceased as if by magic. Where the leathers formerly lasted a week they now hold up for months at a time, with the resulting economy in less cost of repairs and in greater production.

C. A. J.

Improving Operation of Chain Wheel

ON A NUMBER of valves throughout our plant we used chain wheel and chain for distant control, but at first experienced trouble because the chain would often jump

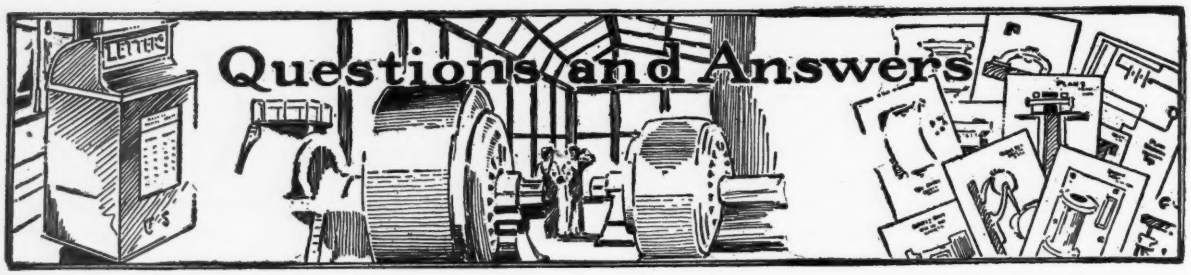


GUARDS TO HOLD CHAIN ON WHEEL

the wheel and fall to the floor. To remedy this we placed two guards on each wheel made of two light arms with a grooved roller on each end, as shown in the sketch, and while they materially improved results, difficulty was still experienced at times when the chain was pulled with a jerky movement because the rollers were not heavy enough to hold the chain in the groove. To overcome this we added a small light coil spring between the two arms in the manner shown, and it is now almost impossible to yank the chain off the wheel.

Where trouble has been encountered with chain and chain wheel controls it might pay to try out the scheme mentioned above.

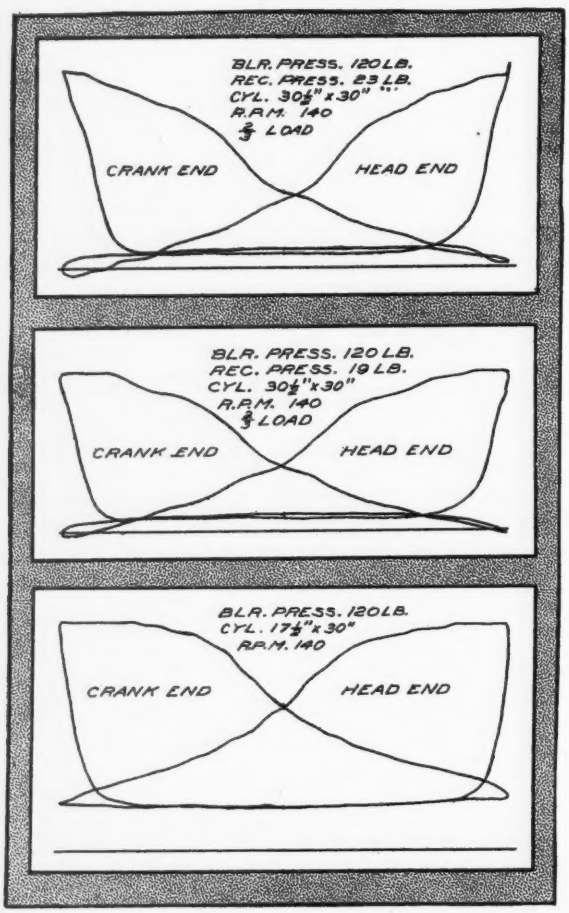
M. A. SALLER.



Why the Receiver Pressure Drop?

SHOWN HEREWITH are three indicator cards taken from a 17½ and 30½ by 30-in. Buckeye tandem compound non-condensing engine which has been in service about 16 yr.

Will some of the readers tell me why the receiver pressure dropped to 19 lb. while I had 23 lb. before I



CARDS TAKEN FROM 17½ AND 30½ BY 30-IN. BUCKEYE TANDEM COMPOUND NON-CONDENSING ENGINE

took compression off or made any adjustments? To run the receiver pressure up to where it should be can be done in three different ways and let the main valve remain in its present position, which appears correct for quiet running and produces a perfect high-pressure card. J. M. K.

In Trouble

I SEE in a late issue a number of engineering societies have gone on record for a law requiring the licensing of engineers. I believe that one of the best moves for everybody concerned, but think a national law instead of a state law should be passed, and believe this would make licensing universal. How about this?

I know of a company owning or operating more than a score of plants in the South, using only two crews for 12 hr. each, which will not employ a union man. The men at work for this company cannot or have not been able to help this cause, for the simple reason that they cannot persuade their employers to listen to 8 hr., which is now recognized by the government. These plants, or a few of which I know, have no baths, toilet or even normal working conditions, and some of their men have been working two years on the night shift of 12 hr., without a change or rest from night work in all that time. How would you better such conditions?

Do the plants in the North make any difference in the pay of the day and night running engineer? In the South they pay the day man more and call him the chief. I believe the night man should be paid the same for the same work, and more if he is on the night run continuously. Your boys in the North sure have a 'gravy train'' in comparison to us of the South, in this regard especially.

What is your opinion of a chief engineer who never reads a trade magazine or book of his trade and also discourages the idea of others reading them?

Will some reader send me a copy of some state engineering licensing law? I would also like to see an article on the setting of pop safety valves, both spring and weight types.

A. OWL.

Calculating Boiler Heating Surfaces

ON PAGE 342 of the April 1 issue appears a letter showing the manner in which I calculate the horsepower of a steam boiler, based upon the number of square feet of heating surface. The editor evidently takes exception to my method, for according to supplemental remarks, he states that in calculating the heating surface of a return tubular boiler it is usual to take ⅔ the diameter of the shell rather than ½, as I have done, and including in the total ⅔ of the area of both tube sheets less the combined area of all the tube openings.

In reply to this, I wish to state that it is the practice of boiler makers so to locate the supporting lugs or loops on horizontal tubular boilers that when the boilers are bricked in, in accordance with the suggestions of a prominent insurance company, the brickwork

will close in at the center of the shell. Therefore ½ of the shell area is to be figured as heating surface.

It is acknowledged that the makers figure such surfaces of both heads as are exposed to the products of combustion; yet it is to be considered that while the gases hug a portion of the back head, in the case of the front end the gases do not come in close contact with the head. The benefits of one are therefore about offset by the other, and when considering the total surfaces in shell and tubes, that in the heads is a negligible quantity, when the vertical position of such surfaces is considered with the above, so no serious error is involved when not figuring the head area.

In operation, conditions are never perfect, and are such that in some cases all the power that can be gotten out of the boilers will not come up to the calculated power, and disappointment in results has been traceable to this. RECEIVER.

Examination for Massachusetts Third-Class Engineer's License

FIND the safe working pressure of a steam boiler, 50 in. in diameter, ⅜-in. shell, double riveted longitudinal seams.

A. Working pressure $= \frac{2\,S\,t\,e}{f\,D}$

S(tensile strength)=58,000
t(thickness of shell)=⅜ in. or 0.37
e(joint efficiency)=82 per cent
f(factor of safety)=5
D(diameter of shell)=50 in.

Working pressure $= \frac{2\times58{,}000\times0.37\times0.82}{5\times50} = 115$ lb.

2. State in detail what action you would take if you had a high pressure of steam on your boiler and you could not find the water level until such time as the boiler was replaced into service.

A. (a) Keep the feed pump operating at normal speed. (b) Either bank the fire with dead ashes, or else haul it out of the furnace on to the boiler room floor. (c) Gradually relieve the boiler of its pressure, and allow it to cool down. (d) Proceed to put the gage cocks and water glass into condition for properly performing their functions.

3. (a) Which part of a horizontal tubular boiler is generally made heaviest? (b) State why.

A. (a) The heads, or flue sheets. (b) For the reason that they are called upon to support the tubes.

4. State what appliances you are governed by to obtain a true water level in a steam boiler.

A. The gage cocks, not less than three in number; and the water gage glass.

5. (a) What is the meaning of "bridge-wall" in a steam boiler, and where is it located? (b) Where is the "mud-drum" in a steam boiler, and what are its uses?

A. (a) The bridge wall is a wall of fire brick extending across, under the boiler at the back end of the grate bars, from one side wall to the other, and up to within 8 or 10 in. of the bottom sheet. (b) The mud drum is a hollow cylinder constructed of the same kind of material as the boiler, but of much smaller dimensions. It is usually located underneath the rear end of the boiler, and connected to it by a throat of ample size to permit mud and other sediment to settle into the mud drum from whence it may be blown out through the blowoff pipe.

6. What are the common causes of boiler explosion?

A. (a) Sheets that have become weakened through corrosion and pitting. (b) Sheets that have been weakened by burning, brought about by low water; or by allowing a heavy coating of scale to form on the inside and thus prevent the water from coming directly in contact with the sheet, while at the same time the outside of the sheet was subjected to intense heat. (c) Subjecting the boiler to a higher pressure than it was designed for. This may be due either to the safety valve refusing to open at the proper time on account of its being stuck, or the safety valve may have been intentionally set for too high a pressure. (d) Insufficient bracing.

7. What is the object of a blowoff, and how often would you examine it?

A. A blowoff pipe is for the purpose of relieving a boiler of all, or a portion of its water; and also for carrying off the mud and sediment from the boiler when it is being washed out. The blowoff pipe should be examined at least once a day if not more often.

8. What is the principal valve on a steam boiler?

A. The safety valve.

9. What are the appliances generally used for feeding boilers?

A. Feed pumps, either steam or belt driven; injectors and inspirators.

10. Name all of the connections which should be placed on a long main steam pipe 50 ft. long, 8 in. in diameter, running from the boiler to the engine.

A. There should be an 8-in. straight-way stop valve as near the boiler as possible; a steam separator; connections of the proper size for supplying steam to feed pumps, and other auxiliary apparatus; and lastly, the throttle valve at the engine.

11. If you were in the engine room, how would you know the boiler was "priming?"

A. If the boiler was priming, and water was being carried over into the cylinder, there would be more or less of a thud, or heavy knock at each stroke of the piston, and very likely a slackening of the speed of the engine.

12. State all the advantages of a steam dome.

A. The advantages of a steam dome are: (a) By its use, steam of a drier quality may be obtained for engine, or other apparatus. (b) It presents a safer location for connecting the steam main to, than does the boiler shell. (c) It furnishes an available point for connecting the safety valve, and whistle pipe to, without having to tap into the boiler shell for these, and other small connections.

13. What are stay bolts, and in what part of a steam boiler are they used?

A. Stay bolts are, or should be, made of the best quality of wrought iron, their diameter being ¾ in., ⅞ in. or 1¼ in., depending upon the size of the boiler, and the pressure it is to carry. They have a screw thread cut their entire length, and are screwed through

both the outside and inside plates of fire box boilers at intervals of 4 to 4½ in. from center to center, thus securely binding the plates together. The ends are allowed to project through the plates far enough to permit of their being riveted down onto the plates.

14. Name the different kinds of patches used on a steam boiler. (b) Which is the most reliable? (c) And why?

A. Riveted patch, and bolt patch. (b) The former is the more reliable; (c) for the reason that it is joined to the main sheet by rivets in the same manner that a lap joint is made.

15. (a) What is meant by "lead?" (b) What is meant by "steam ports?"

A. Lead is the amount of opening given to the steam port by the valve when the engine is on the dead center. (b) The steam ports are the passage ways by which the steam passes from the steam chest into either end of the cylinder behind the piston.

16. State how you would square a shaft with the cylinder if the shaft is out of line.

A. Remove the piston, piston rod, crosshead and connecting rod. Then turn the crank shaft over so as to bring the crankpin on the lower portion of its travel. Next stretch a fine wire (piano-wire is best) through the empty cylinder, carefully adjust it to the exact center of the bore and securely fasten one end of the wire to a wall or other object several feet back of the cylinder, while the other end of the wire must be firmly secured at a point several feet beyond the sweep of the crank. This wire, when adjusted to the center of both ends of the cylinder, will thus be a prolongation of the axis of the cylinder beyond the crank shaft. The crankpin being now under the line, turn the shaft until the pin is brought as close as possible to the line without touching it. While in this position, measure the distance of the line from the fixed collars on the crankpin, using for this purpose a steel scale or inside calipers. The line should be equidistant between the fixed collars on the crankpin. If it is not, adjust the outer bearing of the shaft so as to bring the crankpin to this position, then turn the shaft in the opposite direction, bringing the pin up under the wire at the opposite part of its revolution, and again measure the distances between the line and the fixed collars. If the line at this point is equidistant from the fixed collars, the shaft is square with the cylinder axis; if the measurements do not agree at both points, the outboard bearing should be adjusted horizontally until the wire cuts the crankpin at the same point, and in the same plane on both ends of the stroke. The center of the crank shaft should also be in line vertically with the wire, and the shaft should be leveled.

17. (a) In setting a slide valve on an upright engine, where would the most lead be given, on top or bottom? (b) Why?

A. (a) If the engine is perfectly counterbalanced, as it should be, the lead should be the same on both ends; but if there is no counterbalance, the lead should be slightly greater on the bottom than on the top. Cut-off should also occur a little later on the bottom. (b) This is done in order to compensate for the extra work required to lift the combined weight of piston, piston rod, crosshead, connecting rod, and crank.

18. What drives the piston ahead when the valve closes?

A. The expansive force of the steam then in the cylinder.

19. (a) How is a leaking slide valve detected? (b) A leaking piston?

A. (a) A leaking slide valve may be detected by a continual blow, or escape of steam through the exhaust pipe. (b) A leaking piston will cause a long drawn out blow at each exhaust.

20. What is the most practical way of finding "clearance" in a steam cylinder?

A. The clearance between the piston and cylinder head at either end of the stroke may be ascertained by removing the indicator pipe connections, or if there is no such pipe, the cylinder cocks may be taken out. Then place the engine on the dead center and insert a thin wooden wedge through the hole at that end, pushing it in until it touches both the piston and cylinder head, and then withdraw the wedge and caliper its thickness at the point of contact with the piston and cylinder head. This will show what the clearance at that end is, and by placing the engine on the opposite dead center, and again inserting a similar wedge, the clearance at that end may be found, in the same manner.

21. How is the supply of steam to and from the cylinder controlled?

A. If the engine is of the single slide valve type, the admission and release of steam to and from the cylinder is controlled by this valve. If the engine is of the Corliss, or other four-valve type, these functions are performed by two steam and two exhaust valves. The supply of steam to the steam chests of most engines is controlled by a governor.

22. What is the effect on an engine if the exhaust is liberated too soon?

A. The result will be absence of a cushion of compressed steam to receive the piston at the end of the stroke and thus counteract the momentum of the moving parts. Consequently there will be a sudden shock or pound at each end of the stroke.

23. What is initial pressure?

A. Initial pressure is the pressure behind the piston at the beginning of the stroke.

24. What is the mean pressure in a cylinder?

A. Mean pressure (M.E.P.) is the average pressure acting upon the piston throughout the stroke, minus the back pressure.

25. What is back pressure?

A. Back pressure is pressure in front of the piston, and tending to retard, or prevent its forward movement.

26. What is meant by expanding steam or working steam expansively?

A. Working steam expansively is effected by cutting off its admission to the cylinder when the piston has completed a portion of the stroke, ⅓ or ¼, as the case may be, and thus permitting the steam in the cylinder to expand down to a pressure much lower than initial pressure.

27. Having a 6-in. cylinder, 10-in. stroke, what size steam and exhaust pipes are required?

A. An engine 6 by 10 in., using steam at 100 lb. gage pressure, and running at a speed of 350 r.p.m.,

would require a 1½-in. steam pipe and a 2-in. exhaust pipe.

28. What is the object of putting inside lap on a valve?

A. The object of inside lap on a valve is to cause an earlier closing of the exhaust port, thereby causing a portion of the steam to be compressed ahead of the piston and serve as a cushion at the end of the stroke.

29. How would you set a valve that was controlled by a wheel governor?

A. If by the expression "wheel governor" is meant a shaft governor, the process of setting the valve is as follows:—(a) Place the engine on the dead center, which means that the piston is at the end of the stroke, and the centers of the crank shaft, crankpin, and crosshead pin are exactly in line with each other. (b) Remove steam chest cover, and having previously connected the eccentric rod with the valve stem, adjust the length of one, or both of these rods so as to bring the valve to such a position at that end of its travel as to allow 1/32 in. opening of the steam port. (c) Next turn the engine over ½ revolution and again place it on the dead center with the piston at the opposite end of the stroke, and notice the position of the valve relative to port opening at that end of its travel. If opening, or lead, is the same as it was at the other end, the adjustment is complete. If not, change the length of valve stem, or eccentric rod so as to divide the difference between the lead openings on the two ends, and thus equalize it for both ends of the stroke. Having once gotten the lead equalized, adjustments for cutoff are to be made on the governor.

30. Which stroke requires the more steam on a horizontal engine, the outward or backward, and why?

A. On a horizontal engine, the cutoff should be equalized; that is, the same volume of steam should be admitted on the outward stroke as on the backward stroke.

Engine and Boiler Questions

WHAT IS the difference between a loose eccentric and a slotted eccentric?

2. How is the Edge Moor boiler braced?

3. How is the Cahall water-tube boiler braced?

R. F. H.

ANSWERS

THE DIFFERENCE between a fixed or slotted eccentric and a loose or shifting eccentric is essentially one of cutoff regulation. In the plain slide-valve engine the eccentric is fastened to the shaft by means of a set screw or key, hence the cutoff occurs at a fixed point in the stroke and cannot be changed unless the engine is stopped and the eccentric moved around on the shaft. This would change the angle advance and consequently the point of cutoff.

Cutoff may be made earlier either by increasing the angle of advance or decreasing the eccentricity, and it may be made later either by decreasing the angle of advance or increasing the eccentricity.

An eccentric constructed in such manner that its eccentricity and angle of advance may be changed without stopping the engine is used on the automatic high-speed type of engine. This type of eccentric, which is called a shifting eccentric, is attached to the governor in such manner that the position of the governor controls the eccentricity and angle of advance, and by this means regulates the speed of the engine by changing the point of cutoff to suit the load carried by the engine. A device of this kind makes it possible to use the simple slide valve and, at the same time, secure a variable cutoff in governing the speed of the engine.

2. The bulges of the headers opposite the drums of Edge Moor boilers are effectively stayed by eight 2½-in. steel bolts anchored through steel "U" plates riveted to the inside of the drum.

3. In a Cahall vertical water-tube boiler there are braces in the upper drum, extending from the bottom to the top. These are through braces, with "Y" connections riveted to the heads. No brace or stiffness is provided in the lower ring.

A Noisy Wattmeter

WE HAVE an electric wattmeter in a residence that buzzes continuously and sometimes changes into a grinding noise which is very annoying.

The only way we can stop the noise is by cutting the current off the line.

I would be glad to get your opinion and learn whether the fault is in the meter or elsewhere.

R. L. A.

A. The humming or buzzing noise referred to is nothing uncommon in electric meters, especially those of the induction type. The writer has had considerable experience with watthour meters, and has found that, while sometimes this trouble can be at least partially remedied, in the greater number of instances nothing can be done to eliminate the noise. Frequently we find the buzzing or humming due to vibration of the cup or disk, and it is often possible to correct matters by replacing the bearings, both upper and lower.

On the other hand, it is frequently found that the noise referred to is due to loose laminations, in which case practically nothing can be done except to rebuild the meter, which, of course, would not prove worth while.

Fuel Oil and Other Questions

PLEASE ANSWER the following questions for me:

1. Does a fuel oil burner using steam for atomizing the oil also have air led into the burner?

2. What is the difference between crude oil and fuel oil?

3. What is the advantage of a double-tube over a single-tube steam gage?

4. What is the rule for determining the diameter of rivet, with relation to the thickness of the plate to be used in the riveted seams of a boiler?

5. What is a drop forging? R. F. B.

ANSWERS

ORDINARILY oil burners using steam for atomizing do not employ air in addition.

2. Crude oil is the oil as taken from the wells, while fuel oil is that portion of the crude suitable as fuel.

3. Manufacturers of double-tube steam gages claim that, in such instruments, the vibration of the hand is

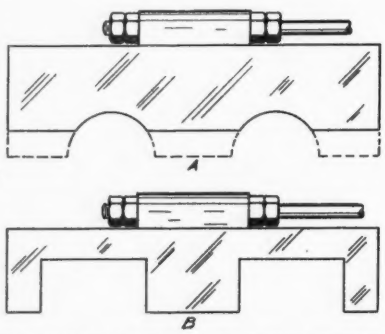
reduced to a minimum. Such gages are particularly suitable for use under severe conditions, as on locomotives and other portable types of boilers.

4. The diameters of rivets should be equal to $1.2\sqrt{t}$ to $1.4\sqrt{t}$, where t is the thickness of the plate.

5. A drop forging is, as its name would imply, a forging made by the dropping of a heavy weight upon the piece of material being worked. Formerly this was done by means of a hand hammer, but due to the ever-increasing size of the forgings, it was necessary to devise other means such as exemplified by the modern steam hammer. A forging made by such a device is termed a drop forging.

Probable Remedies for Peculiar Pump Action

RELATIVE to the peculiar pump performance related by C. C. H., I would say that I had similar experience with a Cameron feed pump which had been in continuous use for over 30 yr. During the last years, however, the pump did not work as well as might be desired. Thoroughly inspecting it, we found the valve worn in the manner indicated at A of the accompanying sketch.



(A) ORIGINAL SHAPE OF VALVE, SHOWING EFFECT OF WEAR
(B) AFTER THE VALVE WAS CHANGED TO THIS FORM NO FURTHER TROUBLE WAS EXPERIENCED

Naturally, this state of affairs caused my troubles, and in order to make the pump operative, we shaped the valve by the cutting away of the surplus iron as shown at B. The trouble was that as the valve wore, the steam jets remained closed for a longer time than desirable, and as a consequence the pump eventually failed to work at all. P. O.

PERHAPS the experience I had with a No. 9 Blake mine pump several years ago might assist C. C. H. in overcoming his pump troubles, as this pump behaved exactly the same as he claims his pump does. It would pump the water from a sump some distance inside of the mine; but when it came to discharging the water up the shaft 120 ft. against 52 lb. back pressure it would fail to operate. It would stick on either end or in the center; it would not work right against any pressure at all. Here is where I found the trouble. The valve seat on the main cylinder, the main slide valve, the combined auxiliary valve and movable seats were all leaking badly; the packing rings in the steam piston were worn and leaking also. I trued the valves and seats and put a new set of packing rings in the steam piston. I tried the pump out in the presence of the mine superintendent and it worked like a charm against the 120-ft. head with the 1½-in. throttle valve ¼ open.

WM. H. MORGAN.

I HAVE HAD the same trouble with pump as C. C. H., and have found that if the valves are properly set that the trouble was due to the use of wrong packing or its improper application. I am sure if C. C. H. will repack his valve rods with a good grade of soft packing, well lubricated, his troubles will at least in part disappear.

D. G. S.

C. C. H. will probably find the steam pressure in the steam chest acting against the area of the valve stem is such as to overcome the friction of the packing in the stuffing box, and so reverse the valve before the full stroke is made.

This can be remedied by either tightening up the stuffing box or renewing the packing, if that is old.

In some cases, where there is a shoulder on the valve stem, the valve starts so quickly that it reverses before it should. In such a case a new valve stem will be required.

In my experience with Blake, Knowles, Deane and Prescott pumps, I find they all act in this way under like conditions. A. W. WILSON.

Why the Leaky Tubes?

AS TO the leaky tubes referred to by A Subscriber, on page 258 of the March 1 issue, I would advise a closer watch kept on the night fireman. It looks like a case of cold air rushing through the bare grates.

This is apt to happen where the combustion chamber is too small; with clean combustion chamber and proper care of draft the boilers should be O.K.

A Subscriber is really the only one to figure the ratings of his boilers. This should be done on the basis of water evaporated, and if he finds he is developing a boiler horsepower for every 3 or 4 sq. ft. of heating surface he need not be surprised, as that is nothing uncommon in this (Portland, Ore.) section of the country.

E. W. SMITH.

Electrical Machine Operation Questions Answered

IN REPLY to the questions of H. A. C. relative to the operation of electrical machinery and as published on page 340 of the April 1 issue, I would state in answer to (a) that the operator was right in tripping out the alternator after it had lost its excitation if he had not time to get his steam exciter up to speed so he could parallel it with the motor exciter, which was slowing down and dropping the voltage. In trying to parallel the two exciters, there might be a chance of the steam exciter motoring the motor-driven exciter, as the voltage on the motor exciter would be getting lower all the time.

If the voltage on the motor-driven exciter had dropped so low that the voltage of the alternator was nearly zero before the steam exciter was up to speed, there would be no use wasting time trying to parallel them and in this case I would pull the alternator off from bus, as was done, and open the motor-driven exciter breakers and proceed to build up voltage with the steam

exciter and get the alternator back in service as soon as possible.

As long as the operator had cut out one current transformer with a jumper, he could also put a jumper over the other current transformer, because he short-circuits the secondary of this current transformer and by doing this he would get no relay protection on that phase and his ammeter would not indicate.

(c.) At time of starting, armature and field windings of a synchronous motor are related to each other as are the primary and the secondary of a transformer; the result is, that when the field coils have many turns of wire, a dangerously high electromotive force may be induced in them; this is the cause of the flash-over.

When the rotary is started, as in the case, directly on full voltage, it draws an excessive current and to avoid this, a half-voltage reactance should be used for starting.

(d.) In this case, the brushes were probably worn so short from arcing that this flash occurred from the brushes leaving the ring and when the arc broke, the distance between brush and ring was so great that the excitation was lost, due to the failure of the current to pass from brush to collector ring.

(e.) Where I am employed, we have a 60-cycle commutating-pole, six-phase rotary converter which is used for railway work. This rotary has flashed over a good deal both in starting and when carrying a load. It usually flashes between brush arms and jumps onto frame of rotary.

Sometimes the a.c. switches trip, due to an interruption on the a.c. system, and the d.c. breaker will stay in and this sometimes causes the rotary to flash over. Sometimes if a heavy overload is put on the rotary suddenly and before the d.c. breaker has had a chance to trip, the rotary will flash over causing d.c. breaker to trip, also a.c. oil switch. The commutator then has to be smoothed up with a commutator stone and sandpaper before starting up again. D. H. R.

Remedies for Cylinder Lubrication Difficulty

With reference to the difficulty H. M. S. is having with the lubrication of his cylinders, I feel that his trouble is due to the circulation of his piston rings rather than to the lubricant he is using and his method of application.

I would suggest that he remove his piston and carefully examine the rings. He undoubtedly will notice that the edges have been worn to the sharpness of a knife blade which, working along the interior walls of the cylinder, will remove the oil as fast as it deposits and thereby cause further undue wear and groaning. If such is the case, I would suggest the filing down of these sharp edges by means of a fine-cut flat file.

H. W. Rose.

The problem of H. M. S., referred to on page 380 of the April 15 issue, can readily be solved by the use of pure natural graphite and the use of a high grade cylinder oil, as outlined in the able article written by Reginald Trautschold, and as published on pages 353 to 358, inclusive, of the same issue.

A dry graphite lubricator should be placed about 1 ft. above the pump. The result will be that the fine particles of graphite will be enveloped by tiny globules of oil, and will be carried to all rubbing surfaces, whereupon the graphite will enter and fill up the pores of the metal, making two absolutely smooth surfaces, between which only a very small quantity of oil is needed to insure perfect lubrication.

If a dry graphite lubricator cannot be secured at once, mix the graphite with the cylinder oil which is being used, fill the oil pump with the mixture and feed at the same rate as when oil is used alone.

After you see the graphite showing on the rod, the quantity of the mixture fed can be gradually reduced until the point is reached where you are getting best results with minimum of lubricant.

Use only a very high grade natural graphite, one that will run over 96 per cent graphite carbon. Do not use an artificial or low-grade natural graphite, as that has not the tenacity, structure, or other lubricating virtues of a high grade natural graphite. You cannot afford to use anything but the best for internal lubrication.

Valentine C. Smith.

Preventing Undue Valve Rod Wear

On page 341 of the April 1 issue, M. N. tells of the undue wear of valve rods he is experiencing. I would suggest that he carefully examine his valve rod brasses and his rocker arm and note their alinement.

If M. N. uses a good brand of packing, well lubricated, and draws up his gland straight, he may have no further trouble, unless, of course, his rod is out of line. D. G. S.

I think M. N.'s trouble is due to the fact that the valve on this engine has either worn down or has been planed off enough to allow the head on the valve rod to bind in the slot on the valve, thus causing the rod to wear on one side. By milling out the slot a little, the head on the valve rod will be given proper clearance.

Arthur Dakin.

Color Scheme for Power House Piping

After reading the answer given to the inquiry of H. K. S., as published on page 297 of the March 15 issue, I felt that it might be of interest to the readers of Power Plant Engineering to learn of power house piping color schemes as employed in other plants. That used in all of the power houses of the Canadian Pacific Railway Co. is as scheduled below. It will be noted that black is used for the exhaust piping, which, to my mind, seems the best color for this particular piping, as it is the one most apt to become oily and dirty.

Live steam	Yellow
Exhaust steam	Black
Compressed air	Dark green
Hot water	Dark blue
Cold water	Light blue
Returns (condensation)	Gray
Fire service water	Maroon
Ammonia	Brown
Brine	Light green
Oil	Purple
Hot water heating	Pink

A. W. Mason.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Office

(Established over 23 years.) Formerly PRACTICAL ENGINEER PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH

BY THE TECHNICAL PUBLISHING CO.
537 South Dearborn Street, Chicago
New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

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Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Circulation of this issue 22,200.

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Don't Neglect Coal Problem

Again we are at that season of the year when it is customary for power plants with proper facilities to lay in a supply of coal for the coming year or get assurances that it will be forthcoming when needed. The conditions existing this year, however, are somewhat different from those of former years when industry was pretty well settled and price conditions could be estimated with some degree of certainty.

During 1917 the daily production of bituminous coal varied but little from the 1,800,000 T. mark. In 1918 the daily production during January averaged about 1,600,000 T., increased gradually with rather sharp declines at the first of April and last of May but reaching maximum points of 2,200,000 in July and September, after which time the production has almost continuously fallen off to the present time when it reached the lowest point for the past three years, 1,167,000 T.

Several causes have, of course, contributed toward this decline in production. A campaign for the storing of coal was carried on last year which undoubtedly had its effect in bringing up the production during the summer and fall months with a resultant decline as the demands for fuel were satisfied. The mild winter which we experienced still further decreased the normal demand. It is quite probable also that many industries are waiting for a reduction in price which is having its effect in causing a lack of demand that is given as the reason for a loss of 46.5 per cent of full time output by the U. S. Geological Survey.

This comparatively small production of coal is a positive indication that little, if any, is being stored at the present time. A continuation of this condition into the summer months will call for extraordinary production during the remainder of the year if a fuel shortage for next winter is to be averted. Combine this fact with the possibility of a coal miners' strike in the late summer, which has been threatened, and there is very good reason why the coal problem should be given serious consideration again.

Helping Soldiers and Sailors

From the date of the signing of the armistice, our men in the service have been returning to civilian status as rapidly as ships could bring them back to this country. The possibility of great numbers of these men lying idle for lack of labor demand was imminent. Appeals were made throughout the country by the U. S. Employment Service for aid in finding positions where their experience and qualifications would be of greatest value. This aid has come in large measure from state and municipal governments by authorizing improvements and voting bonds to carry them out as rapidly as possible. Large corporations and business associations have also co-operated with the Employment Service in bringing it in touch with concerns which are doing or contemplating construction work in the near future.

The work of this department was greatly handicapped, however, by the failure of Congress to pass the appropriation bills necessary for carrying on the work as had been planned, so the situation is in no way what it should be. Compared with what it was a month or

more ago, however, the Department of Labor states in a letter to the editor, that "The situation, thanks largely to the support of the periodicals of the country, is greatly improved, and the United States Employment Service is now assured of continuance, provided this support is further extended."

Much aid has also been given by welfare organizations since the cutting down of the appopriation reduced the offices from 750 to 56, until now the Employment Service has reached a total of 400 regular offices and something more than 2000 co-operating bureaus. It is estimated that approximately 35 per cent of the discharged soldiers leave service without prospects of positions, and 80 per cent of these are being placed by the Employment Service, which is working with three principal functions in view.

First: The Service must be in position to transfer labor from one point to another where needed throughout the country according to conditions of surplus and shortage, with a functioning personnel capable of finding the right man for the job.

Second: It must be able to ascertain from the applicant for employment, particularly the skilled worker, his exact qualifications so that he may be sent to the work that he is best qualified to do, and that the employer at the same time, may get the exact man he needs.

Third: It must be in position to gather, week by week, information of the labor and employment situation from all parts of the country, and according to particular industries.

Engineers and owners of power plants can perform a needed service by applying to the nearest office of the Employment Service for help when in need of men for any class of work. The likelihood of securing the right men here is greater than anywhere else at this time and the service is nation wide.

Across the Atlantic by Air?

IT would be a bold man who would declare anything impossible to an airplane, after seeing what the airman can do with his craft, and remembering the progress made in 4 yr.

Engineering of London gives, however, some interesting data from which the difficulty of trans-Atlantic flight may be judged. Contrasting the airship and the airplane, it is found that with fuel carried 30 per cent of the gross weight of the machine, the ship has over three times the flying radius of the plane. This is due to the greater tractive force in proportion to weight needed by the plane than by the ship, and the moderate speed at which the airship can travel, thus reducing head resistance. The limit of a continuous flight is estimated as 1136 mi. for a plane and 3430 mi. for a ship under the supposed conditions.

Lanchester estimates that with a plane designed to reduce resistance to a minimum, a flight of 2000 mi. might be made by a plane. As this is about the distance across the Atlantic Ocean, the conclusion is that non-stop trans-Atlantic flight will only be made as a freak performance, and cannot be reduced to a regular traffic. A regular route must have at least one calling station for taking on fuel.

Further, as the atmospheric drift is always easterly, even if a continuous flight from America to Europe is made, return flight will be unattainable on account of the wind resistance.

For such air craft as would be suitable for oversea traffic, the figures are given as follows:

Airplane—Weight, 8 T.; speed, 90 mi. per hr.; power, 1200 hp.; fuel, 3.5 T. Running at 1000 hp. and 0.5 lb. fuel per hp.-hr., will use 500 lb. an hr., and can fly 14 hr.; distance, 1260 mi. Atmospheric drift, 30 mi. per hr., or 420 mi. in 14 hr., hence flying east the trip could be 1680 mi.

Airship—Weight, 60 T.; speed, 65 mi. per hr.; power, 1500 hp.; fuel, 17 T. Using full power, fuel per hr. will be 750 lb., and can travel 45 hr.; distance, 2925 mi.

These figures would indicate that the airplane cannot, ordinarily, make a non-stop crossing of 2000 mi., while the airship might easily do so, even allowing for moderate adverse winds. If, however, the head wind rose to 40 mi. per hr., it is doubtful if even the airship could make a non-stop crossing.

To show the jump from past performance in order to accomplish trans-Atlantic flight, the record for non-stop flight and perhaps the nearest to a trans-oceanic flight, was the trip London to Constantinople and back to Saloniki, when the cruiser Goeben was bombed, the distance covered being over 2000 mi. and the time 31 hr. The plane was a Handley-Page with 100-ft. wing spread and 275 hp. and carried five men.

Data is not available as to performance of airships, as these have, for the most part been of German development, but it is understood that a British ship is nearing completion which has an estimated endurance of 211 hr. at 45 mi. per hr., which would give a flight of 9500 mi., and that the 1918 German Zeppelins showed 177.5 hr. at 45 mi. per hr., or a trip of 8000 mi. These are newspaper reports and to be taken with a grain of salt, but even with 50 per cent deduction, these aircraft should negotiate the trans-Atlantic trip easily. From St. Johns, Newfoundland, to Ireland is 1860 mi., and to the Azores is 1195 mi.; from the Azores to Lisbon, 850 mi. more.

Optimistic airmen would seem, therefore, to have good reason for their belief that a non-stop trip can be made by airships, and a one-stop flight by airplanes, spite of the figures given by Engineering. It does not seem improbable that these things may be accomplished during the coming summer, but it will be a long step from a single flight to established commercial flying, and it is a serious question whether the demand for such transportation at the high rates which must be paid will be sufficient to make such an enterprise pay.

A WRITER in The Scientific American states that common salt is an efficient decarbonizer. First get the engine warm and in easy starting condition. Then remove the spark plugs and pour a teaspoonful of common salt into each cylinder. Replace the plugs and start the engine and "the carbon will pour from the exhaust."

SUPPORT the Victory Liberty Loan with all the money you have or can save. Only by keeping the Government credit solid and secure can we hope to escape some of the dangers that threaten Europe.

Latest Design of Small Air Compressors

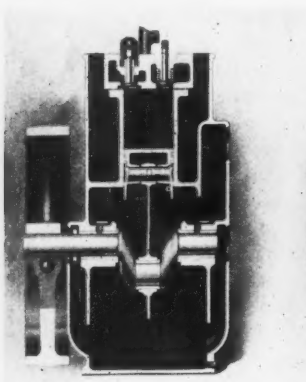
WHEN, in the emergency at the outbreak of the war, there was a sudden call for a large number of small air compressors for service where reliability was imperative, the type illustrated herewith had just been completely tested out and was accepted.

There are four sizes and the capacity range runs from 3 to 45 cu. ft. per minute at pressures to 100 lb. per sq. in. The small compressors can, however, be used for pressure requirements up to 200 lb. per sq. in., the horsepower needed being, of course, slightly increased. They are single acting machines of the vertical type built for belt drive.

The machines are so well balanced as to operate satisfactorily if bolted to any solid flooring, but where permanency of installation is desired the building of a concrete foundation is advocated. The smallest size is built with ribbed cylinder for air cooling where the service is intermitent and with water cooled cylinders of the reservoir type for continuous operation. Larger machines are water cooled only, employing the reservoir jacket system except that, in the case of the largest size, a closed jacket for connection to pressure system is optional. In this connection it is worth noting that the reservoir cylinder design affords unusually ample water capacity and that both cylinder barrel and head are cooled. The manufacturer states that a single filling of the water space will suffice for a 10-hr.-day's run.

In general design these compressors remind one strongly of an automobile engine. There is the same drop forged crank shaft and connecting rod, the die cast renewable bearings, the automatic splash lubrication system and general ruggedness and simplicity which have come to be recognized as guarantees of satisfactory service under all sorts of operating conditions.

It is pointed out, however, that these little units were designed to meet exacting efficiency test and that, while simplicity was sought, efficiency was the outstanding requirement.



SECTIONAL VIEW OF SMALL AIR COMPRESSOR

A New Type of Conveyor

TO SECURE economical operation and greater efficiency in handling material, labor must be supplanted by machines and these selected which are best adapted for the particular work. Men with wheelbarrows are too costly to use in storing, moving or loading material and a great deal of labor is needed in shoveling material into receiving hoppers.

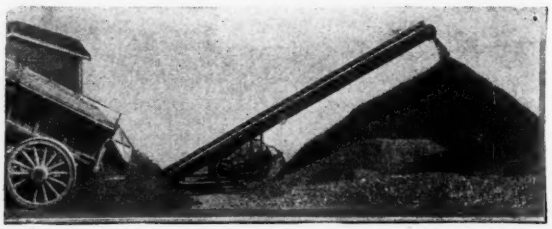


FIG. 1. UNLOADING FROM WAGON TO STORAGE PILE WITH A SCOOP CONVEYOR

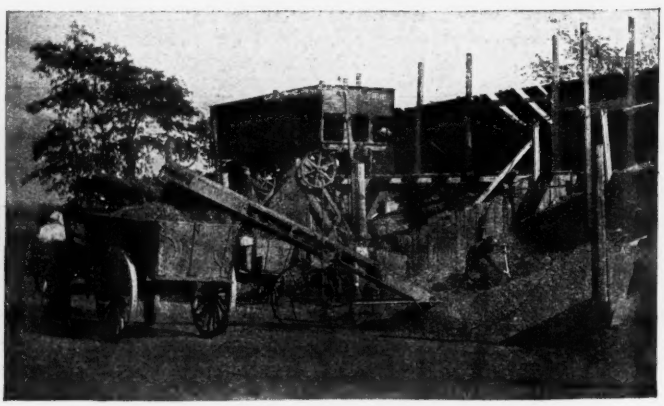


FIG. 2. LOADING TRUCKS WITH A SCOOP CONVEYOR

A new type of portable conveyor, which cuts the labor is shown in the accompanying illustrations. The most distinctive feature of this machine, called the Scoop Conveyor, is the scoop on the feeding end, which can be pushed or completely buried into the material to be conveyed. This makes it possible simply to scrape the material onto the carrying belt.

Another feature is the construction of the sides or skirt plates as they are called. These form a trough which enables a 12-in. wide belt to equal in carrying capacity a 20-in. troughed belt. This is readily understood when one remembers that on a troughed belt the material is carried in the center or trough, that on the sides falling into the trough or rolling back; whereas, the side plates on the scoop conveyor hold the material together, giving the whole width of the belt carrying effectiveness. It is due to the skirt plates, also, that a 24-ft. long scoop conveyor will convey material as high as a 30-ft. troughed belt.

The money savings resulting from the use of a Scoop conveyor are due, first, to the saving in labor; second, to the speed at which material is conveyed. In comparison with handling material by hand, one or two men with a Scoop conveyor will do the same work as from four to twelve men, depending upon conditions. The Scoop conveyor will load trucks in ¼ to 1/6 the time required by men shoveling. It often enables one truck to do the work of two trucks and of getting two days' work done in one day.

Storage capacity is another factor of saving attributed to this machine as it increases the available capacity of a shed or yard space by enabling the men to pile higher.

FIG. 3. USING THREE SCOOP CONVEYORS TO UNLOAD FROM HOPPER BOTTOM CARS TO LARGE STORAGE PILE

The carrying capacity of the Scoop conveyor, based on handling coal, is one ton per minute, provided a sufficient amount of coal is maintained at the receiving end of the machine. If the storage pile is of sufficient height, one man can easily feed 1 T. in 1½ min., or if the pile is low, he may require from 2 to 4 min. Where speed is required, two men may be provided for feeding. In unloading hopper bottom cars the machine and one man can remove 1 T. per min.

Large size coal, coke, crushed stone, etc., fed by one man require from 3 to 6 min. for 1 T., or half that time with two men.

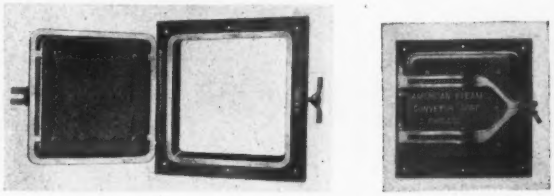
The conveyor is used principally for storing, reclaiming and loading bulk material and light articles. There are an unlimited number of uses for the machine, in addition, such as elevating material to tanks or platforms in chemical and industrial works, feeding from cars and delivering into fixed conveyors or stoker magazines at power plants, etc. Almost any kind of material can be handled, such as coal of all kinds, ashes, sand, earth, crushed stone, blast furnace slag, ore, fertilizer, salt, chemicals, grain, bags and light packages. The Scoop conveyor may be used singly, in tandem or in triplicate as may be required. The employment of sets of two or more allows for an increase in height of the storage pile or conveying distance. Figure 3 illustrates three machines unloading coal from hopper cars up a long steep incline.

The Scoop conveyor is strongly constructed, light in weight, compact and portable. The steel frame holding the rollers and conveying belt is mounted on the wheels so that the balance is perfect. One man, by inserting the pipe handles into the ends of the horizontal members can easily lift and move the machine around. The electric motor or gasoline engine mounted under the frame transmits power to the conveyor by means of a chain and sprocket connection to a shaft extending beneath the conveyor. From a sprocket on the other end of this shaft the power, in turn, is transmitted to the driving sprocket, located at the upper end of the conveyor. The carrying belt is of heavy duck and rubber with duck cross strips to prevent the material from slipping back down the incline.

This conveyor is made in three different sizes, 13 ft. 8 in., 19 ft. 8 in. and 24 ft The width of the conveying belt on any of these sizes may be either 12 or 16 in., as desired. The smallest size elevates to a total height from the ground of 5 ft. 9 in., the next size may be adjusted for any height from 6 to 9 ft., and the largest size may be adjusted for any height from 9 to 12 ft. The machines are furnished with electric motor or gasoline engine, or where customer prefers to furnish and install motor himself, motor support and drive from motor shaft are provided.

New Air-Tight Ash Pit Door

A PERFECTLY tight ash pit door is essential to prevent combustion in the ash pit and also in preventing excess air from entering the boiler through some types of stokers. Plant economy and ease in handling ashes are features which should be carefully



AIR-TIGHT ASH PIT DOOR IN OPEN AND CLOSED POSITIONS

considered in choosing ash pit doors, not only for the ash pits of new power houses, but also for old plants.

Consulting engineers and architects are often required to draw detailed specifications for ash pit doors, because they have been unable to find a satisfactory article on the market as a standard piece of equipment. Contractors engaged in setting boilers are also often required to construct a cheap steel door on the job because they had been unable to purchase a good cast-iron door especially designed for the purpose.

The door illustrated here is a manufactured article and has been produced as the result of careful tests and study, covering all points essential to successful operation and durability.

It has been the experience of ash disposal engineers that an ash pit door should be of ample size to allow easy removal of the ashes from the pit, but should not be unnecessarily large. If too large, it is impossible to keep the door from warping and thus leaking air, and it is also too heavy to be handled easily. A 24 by 36-in. door is ample for the largest pit, and this is the size recommended for ordinary use. Three other sizes of doors are also built of the same general design. These are in size 18 by 18 in., 22 by 26 in. and 24 by 24 in.

The frame of this door is of cast iron of ample strength for all conditions, with the hinge and locking logs cast on. The frame is of an angle design and sets well back into the setting. It is easily fastened into the pit wall by four bolts, one in each corner. The bearing surface is carefully machined. The hinge lugs are of ample strength to meet the hard usage to which these doors are subjected in operation.

The door itself is of heavy cast iron and is provided with a heavy ventilated cast-iron liner to prevent contact with the hot ashes and consequent warping. The bearing surface of the door is also carefully machined to make an air-tight joint with the frame.

The hinges are of the floating type, and two are provided. The hinge bars are pivoted to the frame and carry the door at the center, where it is pivoted to the bars. This gives a perfectly distributed pressure over the door and keeps a tight joint at all points, with no possibility of a clinker in the corner of the frame opening, breaking or bending the door by a wedge action. It also allows the door to be swung entirely out of the operator's way.

This door is easily, quickly and tightly locked by means of the wing nuts at the end of the hinge bars. In the case of the 24 by 36-in. door, two locks are used. The other sizes have but one locking lug.

News Notes

THE ANNUAL state convention of the Iowa N. A. S. E. will be held this year at Marshalltown, June 11, 12 and 13. Marshalltown is one of the most progressive industrial cities in the Middle West, being the home of many factories, which, together with an interesting program, should bring a large attendance. The tentative program consists of papers on the Uniflow Engine, a talk on Flow Meters, Isolated Plants, talk on James Watt, Development of the Steam Gage, Plant Operating Economies. Visits to many of the plants have been arranged, also a big banquet on the closing day at 7 o'clock at the Pilgrim Hotel, the headquarters, at which time Professor W. H. Meeker of the Iowa State College at Ames will be the principal speaker. A mechanical exhibit will also be held.

TWENTY-FIVE HUNDRED jobs for ex-service men were made available by the United States Shipping Board when it ordered its recruiting service to accept at once that number of young Americans between 18 and 35 yr. of age for training as sailors, firemen and stewards in the Merchant Marine. As men accepted for Merchant Marine training need not have had sea-going experience, the door was thus opened wide to ex-soldiers, from whom the board has recently received many applications for employment on the new merchant ships. The board's call was to fill the places of apprentices now finishing their training for the Merchant Marine and shipping out in the crews of new merchant ships, which are now coming along in large numbers. On the Great Lakes alone the Shipping Board this month will provide crews for not less than 100 new ships which will come down to the seaboard in the opening of navigation. Two thousand of the 2500 men called recently will be given intensive schooling on training ships based at Boston and 500 on the Pacific Coast.

THE U. S. CIVIL SERVICE COMMISSION announces examinations for the following positions: May 21—Highway Bridge Engineer, $1800-$2100 a year; Junior Highway Bridge Engineer, $1200-$1600; Draftsman (male or female), $1080; May 27—Assistant Physicist, Qualified in Aeronautics, $2100; May 29—Chief of Road Survey Party, $1800-$2100; Transit man for Road Surveys, $1200-$1800; Highway Draftsman, $1200-$1800.

THE BAILEY METER CO. will move its main office and works from Boston to Cleveland, Ohio, effective May 1.

With H. D. Fisher as manager, the Boston office is retained to handle sales and engineering service work in the New England district. For the present, New York and Philadelphia districts will be covered from Boston and all other districts will be served from Cleveland.

BADENHAUSEN CO., Philadelphia, announces the opening of additional sales offices at Pittsburgh, 311 Jenkins Building, under management of A. D. Neeld, Jr., and also at Chicago, 1225 Marquette Building, under the management of J. F. O. Stratton.

THE AMERICAN STEAM CONVEYOR CORPORATION, Chicago, announces the appointment of Charles H. Florandin, formerly of the National Electric and Welding Co., New York, as general manager of its eastern territory, with headquarters at 110 W. 40th St., New York. Mr. Florandin, who assumes charge of his new duties May 1, was born in France and received his technical education at the Lycee de Marseilles. He is an engineer by profession, and upon coming to the United States did important work with the Brooklyn City Railway Co. in the early days when the road was being electrified. After 5 yr. service with this company he joined the C. & C. Electric Co., New York, where he held a responsible position for many years.

After a brief connection with the Western Electric Co. he returned to the C. & C. Electric Co., and later organized the National Electric and Welding Co. During the war Mr. Florandin was a member of the Welding Committee of the Emergency Fleet Corporation, and here did valuable work for our country.

LIEUTENANT COMMANDER H. J. ELSON, U. S. Naval Reserve Force, has been released to inactive status and has resumed his civilian work as secretary and treasurer Walter A. Zelnicker Supply Co., St. Louis, with which company he was in charge of internal management and manufacturing operations.

Lieutenant Commander Elson was graduated from U. S. Naval Academy in 1898, and after service in Cuba, the Philippines and China, resigned from the Navy in 1902 to become interested in the Zelnicker Co.

He was chief engineer of the Missouri Naval Militia, with which organization he was mobilized into Federal service upon the declaration of war, April 6, 1917.

His assignment was Inspector of Machinery, 9th, 10th and 11th Naval Districts, with headquarters at Chicago, where he had charge of the design and conversion to salt water use of Machinery Department of Great Lakes Vessels taken over by the Navy Department.

Lieutenant Commander Elson will have the general internal management of operations and manufacturing of the Zelnicker Co. and its various allied subsidiaries.

THE TRILL INDICATOR CO. proposes to give one steam engine indicator away absolutely free, with a planimeter as second prize, to the men who can show the greatest per cent of increase in salary due to the use of the engine indicator. They state that the contest will not be exclusively confined to the users of the Trill indicator, but will be open to users of all makes of instruments.

They are uncertain, however, as to whether engineers generally would be interested in such a contest, and state that they will institute this contest only if they receive encouragement from engineers. If interested, simply drop them a postal card saying: I am with you in your contest. Address it: Trill Indicator Co., Pine St., Corry, Pa.

OF INTEREST to all users of bearings is the just announced combination, effective May 1, of the Hess-Bright Manufacturing Co., the S K F Ball Bearing Co., the Atlas Ball Bearing Co. and the Hubbard Machine Co. The new company, under the name of S K F Industries, Inc., will offer a comprehensive line of ball bearings.

Through the medium of its engineering organization, backed up by a well equipped laboratory, the new company will be able to place at the service of bearing users the knowledge gained in many years study of anti-friction bearings of all kinds. On request, manufacturers' problems will be analyzed in detail and that type of bearing recommended which (independent of sales considerations) is best suited to the conditions met. In addition the laboratory staff will carry on research studies affecting anti-friction bearing design and application.

S K F Industries, Inc., is the consummation by physical consolidation of a merger, begun some time ago, of the four companies mentioned under the direction of B. G. Prytz, president; W. L. Batt, vice-president; J. P. Walsh, comptroller, and S. B. Taylor, sales manager. The principal office will be at 165 Broadway, New York City, with branches at Boston, Philadelphia, Atlanta, Buffalo, Cleveland, Detroit, Cincinnati, Chicago and San Francisco.

THE STEAM MOTORS CO., Springfield, Mass., announces that Raines Kessler and Louis Lanyi, transacting business under the name of the Engineering Service Sales Co., with offices at 8 W. 40th St., have been appointed as New York representative for the territory comprising the eastern portion of New York state, the northeastern portion of Pennsylvania, the northern half of New Jersey and Connecticut west of the Connecticut River.

Mr. Kessler was for a number of years connected with the Terry Steam Turbine Co., and for a time Chicago manager. More recently he was connected with the Green Fuel Economizer Co. at New York. Mr. Lanyi has been connected with the Green Fuel Economizer Co. for several years as chief engineer of the Fan Division, and has specialized in the design and application of high speed, high efficiency blowers for use in industrial and power station work.

TO SUPPLY better the demand for its products in the Oklahoma and Kansas fields, the Chicago Pneumatic Tool Co. has opened offices and warehouses at Tulsa, Okla. (313 Richards Building), and at El Dorado, Kan., having discontinued its office at Wichita, Kan. Stocks of repair parts and the company's products will be maintained at both of these points to facilitate prompt deliveries to their customers in this territory.

A NEW PIPE threading device known as the No. 3 Beaver Junior has recently been placed on the market, this tool is built on the "unit" plan to thread ⅛, ¼, ⅜, ½, ¾ and 1-in. pipe and consists of a ratchet handle and separate die heads to thread each size of pipe. It makes an ideal tool for the home as well as a very practical tool for the workshop.

The No. 3 Beaver Jr. possesses certain unique and valuable mechanical advantages. For instance, the ratchet mechanism is entirely encased so that it is impossible for dirt or grease to accumulate and retard the action of the tool; this is an important advantage. The introduction of 1-in. size to the range is another advantage which will be greatly appreciated.

Book Reviews

ELEMENTS OF FUEL Oil and Steam Engineering, by Robert Sibley and Chas. H. Delany; 320 pages, illustrated; first edition, 1918; San Francisco. Price, $3.

Engineers in charge of power plants employing oil as fuel should find this little volume of considerable value.

The book has as its underlying theme, a study of fuel oil power plant operation, and the use of evaporative tests in increasing the efficiency of oil fired plants. To accomplish this end, the subject matter has been treated in three main divisions: First, an exposition of elementary laws of steam engineering; second, the processes involved in the utilization of fuel oil in the modern power plant; and, third, the testing of oil-fired boilers.

In treating the first subdivision, the elementary laws of steam engineering are set forth in a new manner, in that the view point is taken from that of the oil-fired instead of the coal-fired power plant operator. In the second subdivision, the results of considerable labor and analysis are set forth from the collecting and collating of data involved in burner, furnace and fuel oil tests, hitherto appearing in disconnected form and in widely varying sources. In the third sub-division, the authors have given definite suggestions for fuel oil tests.

The volume is well illustrated and the subject is handled in a very simple and direct manner, thus well adapting the work to the needs of the central station man, the power plant operator, the mechanical engineer and the student.

CAUSES and methods of prevention of errors in pyrometer equipment have been given little or no publicity up to the present time, although the failure and rejection of a large percentage of many products may be traced directly to such inaccuracies. This applies not only to the iron and steel industries, where pyrometers are used most extensively, but also to the ceramic industry and the chemical industry. In gas and steam making plants also, there are opportunities to increase efficiencies greatly by the use of pyrometers. Many of the most common errors found in pyrometer installations are due to simple causes which could be easily remedied if the user were acquainted with the necessary precautions to be observed in the installation and care of his instruments.

In a large number of plants the pyrometers are seldom or never checked. In many cases this lack of checking is because the user is not familiar with commercial checking methods and the necessity for using such methods.

These facts are brought out and thoroughly discussed in a new book just issued by Leeds & Northrup Co., of Philadelphia, entitled, "Checking Thermocouple Pyrometers." It discusses the importance of maintaining standards and of checking in pyrometry. It points out sources of error and the remedies for troubles in thermocouples, millivoltmeters, cold junctions and potentiometers. It outlines a commercial checking laboratory, including a special checking furnace, precision potentiometers and standardized thermocouples. This bulletin is distributed free of charge and should certainly be in the hands of every manufacturer, the quality of whose product depends upon temperature control by pyrometric means.

A SERIES of tests has been conducted by the Engineering Experiment Station of the University of Illinois to obtain experimental information concerning the stresses in the reinforcement and in the concrete, the continuity of the composing members of a frame, the location of sections of critical stress, the reliability of a reinforced concrete frame and the applicability of the theoretical formulas in the design of frames. Formulas for moments and other indeterminate quantities for several types of indeterminate structures have been derived. To test practically the reliability of these formulas for reinforced concrete structures, eight test frames were designed according to the formulas found by the analyses, and the deformations produced in the various parts of the members by the test loads were measured. The specimens were made in November and December, 1913, and January, 1914, and were tested in January, February and March, 1914. The following cases have been analyzed for vertical load: (1) single story, single span; (2) single story, three spans; (3) trestle bent with tie, single span; (4) building frame with several stories and several spans; and (5) bridge trestle. For horizontal load the following cases have been analyzed: (1) single story, single span; (2) octagonal reservoir or tank; and (3) rectangular reservoir or tank.

The formulas found from the analyses and graphs showing the main stresses that were observed at the principal loads are published in Bulletin 107, entitled "Analysis and Tests of Rigidly Connected Reinforced Concrete Frames," by Mikishi Abe, under the direct charge of Professor Arthur N. Talbot, Department of Theoretical and Applied Mechanics, University of Illinois. Copies may be had without charge by addressing the Engineering Experiment Station, Urbana, Ill.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

required by the Act of Congress of Aug. 24, 1912, of Power Plant Engineering, published Semi-Monthly at Chicago, Ill., for April 1, 1919.

State of Illinois } ss.
County of Cook }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Chas. S. Clarke, who, having been duly sworn according to law, deposes and says that he is the Secretary of the Power Plant Engineering, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of Aug. 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are:

Name of— Post Office Address—
Publisher, Technical Publishing Co., Chicago, Ill.
Editor, Arthur L. Rice, Chicago, Ill.
Managing Editor, None.
Business Manager, E. R. Shaw, Chicago, Ill.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent of the total amount of stock.)

Technical Publishing Co., Chicago, Ill.
E. R. Shaw, Chicago, Ill.
A. L. Rice, Chicago, Ill.
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3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities are: (If there are none, so state.)

There are none.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest, direct or indirect, in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is.....

(This information is required from daily publications only.)

Chas. Sanford Clarke, Secretary.

Sworn to and subscribed before me this 28th day of March, 1918. Warren A. Lathrop, Notary Public.
(SEAL) (My commission expires Oct. 16, 1922.)

NOTE.—This statement must be made in duplicate and both copies delivered by the publisher to the postmaster, who shall send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the post office. The publisher must publish a copy of this statement in the second issue printed next after its filing.